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Why Is the Pacific Higher Than the Atlantic Ocean?

The ocean on our Pacific coast is 2 ft. higher than on our Atlantic coast. Why?

The prevailing winds and ocean currents are from west to east, and this would tend to pile up the water to a higher level on the west coast than on the east coast of the continent. But this answer only goes one step toward solving the riddle. Why are the prevailing air and ocean currents easterly in trend?

The earth rotates on its axis in an easterly direction, and it would seem natural that its atmosphere would rotate in the same direction but at a slower speed; in which case our prevailing winds would come from the east, which is not in accord with the fact.

When in 1883 Krakatoa exploded and sent its powdered rock up 20 miles or more, it was soon discovered that there is a current of air a few miles above the earth that moves with almost hurricane velocity (70 miles an hour) from west to east, constantly, for the dust travelled around the earth at that rate. This is a phenomenon that has not received adequate investigation, for it obviously must have a marked effect on our weather.

According to the etherite theory of self-propulsion of stellar bodies, the gradual exhaustion of the etherites from the electrons would reduce the centrifugal force and cause the bodies to move nearer to their center of revolution. They would describe a spiral ellipse, and not a closed ellipse; and as they near the center they would revolve faster. If the planets are composed of star dust ejected from sunspots, and if each planet was itself once a molten "sun" having sunspots from which its moons were ejected it follows that all space is occupied by star dust that is revolving about some center.

Since these particles are slowly approaching their center of revolution, some of them are constantly impinging upon the stellar bodies—suns and planets—and with a velocity greater than the rotative velocity of the stellar body. This not only would cause the stellar bodies to rotate on their axes, but to change their rate of rotation. The impact of star dust upon the air would give to the air a rotative velocity greater than that of the earth. This velocity should be greatest around the equator, according to this theory, for most of the original star dust emitted from the earth would be in a belt surrounding the equator. While we do not yet know the different rates of rotation of the air at different latitudes, we do know that the sun's atmosphere rotates fastest near the solar equator.

The eastwardly trend of the air would impart an eastwardly trend to the ocean beneath, and this would cause a higher level on our Pacific than on our Atlantic coast.

Robert W. Hume

For the third time since I engaged in the publishing business I have lost one of my closest associates; first in the death of Myron C. Clark, later in the death of Lewis S. Louer, and now in the death of Robert W. Hume. Differing as all men differ, they had in common one outstanding trait: They loved their fellow men. And in return they were loved by all who knew them well. What better can any man ask while he lives than to be surrounded by such friends as theirs? What better can he look forward to when his earthly end comes than that he shall never be forgotten by those friends?

Bob Hume was so dynamic, so full of whimsical humor, so effervescently optimistic, the personification of vitality, when last I saw him, that I can hardly realize that he is dead.

His was the rarest combination of great intellectual brilliancy and buoyant, lovable optimism. As a raconteur I have never heard his equal, for not only could he paint a vivid word picture in the best of language, but he could inject into it something of his own dynamic personality, which gave the picture a fascinating verve. He would have succeeded greatly as a writer, I believe. His letters indicate that, but his spoken words certainly proved his ability to charm and interest the listener.

Like Clark and Louer, Bob Hume endeared himself to all who knew him. His sympathetic interest in his fellow men won, in return, their interest in him. Yet he was no yes-yes man. He had most positive convictions and the courage to state them, even in the face of an opposition that might end in trouble. But he never failed to win respect for his convictions, because his sincerity was so pronounced as to be evident to every one.

Honest to the core, courageous to the limit, brilliant far beyond the capacity of most intellects, sympathetic in the extreme — admirable and lovable — that was Robert Hume.

The Evolution of a Scientific Theory

There is a very common belief among scientists that correct inferences often are drawn from false theories; that truth emerges from fiction. Yet every thinker must instinctively rebel against any such belief, and yield to it only because many other thinkers have adopted it as part of their scientific creed.

Even those scientists who have stated that false theories often yield results that are true, have also stated that the final test of the truth of any theory is its agreement with facts. Witness, then, their dilemma. In one breath they say that the ultimate test of any theory is its agreement with the facts, only to cast aside such a test when in the next breath they say even false theories may agree with the facts; for when they admit that correct inferences may be drawn from a false theory they really say that a false theory may be in perfect accord with the facts.

A scientific theory is an explanation of some phenomenon, and the explanation consists either in showing the likeness of the phenomenon to some well known class of things, or in showing the causes that produce the observed effects. If we start with the assumption that no scientific theory is or ever will be perfect, we may readily avoid the logical paradox of drawing correct conclusions from a false theory; for we shall not be claiming absolute truth for any theory, but only an approximation to the truth. Then it becomes very apparent that we are not using the word "false" in the common sense of the term when we call a theory "false" because it falls short of perfection. As well call a man a liar if he says that the time by his watch is 10:15, when it really is 10:15:10.

A theory that is in approximate accord with the facts over a wide range of conditions is probably correct or true in a basic sense. Thus the theory that heat is a fluid (phlogistom) that flows from regions of higher pressure (temperature) to regions of lower pressure at a rate based upon the difference of pressure explains many facts of heat conductivity. But this theory was later declared to be "false" when the theory of "heat as a mode of motion" came into vogue. Scientists are now beginning to see that it is as proper to speak of heat as if it were a substance, as it is to speak of iron as a substance. So and so many tons of heat reach the earth daily from the sun, we are now told by those who have adopted Einstein's theory of energy. Hence the "false" phlogistron theory—discarded for generations—is back on the scientific stage again in new garb. Similarly as to the discarded fluid theory of electricity. Similarly as to the discarded theory that all the atoms are built of hydrogen bricks. Similarly as to the discarded corpuscular theory of light. And so with scores of theories that served to explain certain phenomena for a while but were cast aside for lack of complete accord with facts, back they come at length with that part of truth that was theirs in the beginning.

Instead of rejecting a useful theory because some later explanation seems preferable, the part of wisdom seems to consist in finding a reconciliation between the new and the old theory. Even when an old established theory seems to be in actual conflict with certain facts, it should not be summarily rejected. Probably it is correct in a measure.

Theories, like inventions, improve with use, for their defects are gradually reduced. Who would call Stephenson's locomotive a false design because we now enjoy designs that are vastly better? Yet already we hear it said that Newton's theory of gravitation is basically unsound because Einstein has developed the fundamental idea somewhat!

There has been a good deal of scoffing at Aristotelian logic in modern times; but a revival of the study of it by scientists may not be amiss. It will be learned, for example, that every term used in reasoning should be clearly defined. Truth, when defined, simmers down to accordance with the facts. Then it becomes clear that even an approximate accordance with certain facts is truth, and may be, for many purposes, all of the truth that we are concerned in finding.

Since the foregoing was written we have read the statement that Bohr's theory of the atom (1927 model) is erroneous and must give place to Davisson's theory (1928 model). All this because Davisson's experiments show that the "ultimate particle" of matter is not an electron, for he has broken electrons up into "waves." It would be quite as logical to call the atomic theory of matter erroneous, because atoms are not the ultimate units.

The editor has deduced the Einstein basic relativity formulas and of theory that makes the electrons consist of particles that may be called etherites, whose escape in rhythmic pulses, or heads, causes the motion of all bodies as well as all gravitative phenomena. If Davisson has succeeded in breaking up an electron in the laboratory, he has done only what is probably happening in nature; but he has made a very important scientific advance none the less. This, however, is a far cry from proving Bohr to be incorrect in his theory that every atom is a miniature solar system whose sun is its positive nucleus and whose planets are orbitally revolving electrons that leap from an inner orbit to an outer orbit and thus produce radiant phenomena like light.

Fortunately for those of us whose business it is to apply science, we are not compelled to unlearn scientific theories from day to day. What we should do is to keep abreast of the evolution of the old theories toward greater perfection.

H. P. Gillette

Announcement

The 1928 edition of the ROAD AND STREET CATALOG AND DATA BOOK is ready for distribution.

This Catalog will be mailed free of charge to the offices of state, county and city, street and highway officials and road and street contractors.

It contains the catalog data of a large number of the most active manufacturers of road and street equipment and supplies.

The Catalog pages of the manufacturers represented have proved of exceptional service to the 20,000 users when they are in need of comprehensive information regarding equipment and supplies.

The Data Section has been revised and enlarged and gives the equivalent of a 500-page handbook of road and street data.

Any one active in the road and street industry who, logically, should receive the Catalog and whose name is not on our list, can obtain the book by mailing us an application for one and indicating his need for it.

Robert Woolsey Hume

Born August 12, 1884 **Died February 10, 1928**

It was only a couple of years ago that it was our sad task to chronicle the death of our well loved friend and associate, Lewis S. Louer, then vice-president of this company; and now with deep sorrow we have to note the passing of his successor, Robert Woolsey Hume. Mr. Hume died February 10, at his home in LaGrange, Ill., after a short illness from pneumonia.

Robert Woolsey Hume was born August 12, 1884, in Bombay, India, where his father, the Rev. Edward S. Hume, had been located since 1875 as a missionary for the American Congregational Board. His grandfather, the Rev. R. W. Hume, also had been a missionary in India, having gone there in 1839. Robert was brought to this country when he was twelve years old. His earlier education was was obtained in the schools at Baltimore, Md., and Auburndale, Mass. He then went to Hotchkiss School in Connecticut, and after graduating there he entered Yale University in the class of 1907. (In passing it may be noted that his grandfather, his father and one brother were graduates of Yale.) The death of his father made it necessary for him to leave Yale in 1906, and go to work. His first job was in Kansas City, Mo. He came to Chicago sixteen years ago, a stranger in a strange city. For several years he was editor and advertising manager of the Acetelyne Journal, leaving that publication in 1919 to join the staff of the Gillette Publishing Company. In 1926 he was elected vice-president of this company, succeeding Mr. Louer. In 1927 he was elected secretary of the Highway Industries Association.

Mr. Hume was married in 1912 to Miss Katharine Rockwell, who with three sons, Robert, aged 14, Paul, 12, and David, 3, survives him.

"He was born, he lived, he died," all this can be said about any man, but more than this can be said about Bob Hume. He was an exceptional man. Loyalty, thoughtfulness, and friendliness were predominating traits of his character. But of all his excellent traits the outstanding ones were his unselfishness and his sincerity. He was the most unselfish man we ever knew, everybody came first with him. He rose in the business world not by stepping upon somebody's head, but by sheer merit. He was absolutely sincere in everything he did and said. When Bob Hume said a thing he meant it; there was no lip service with him. When he did a thing, he did it because he was thoroughly convinced that it was the right thing to do.

Bob Hume was essentially a friendly man. He had the happy facility, to an uncommon degree, of making friends and of keeping them. He always was eager to be of service to his friends and he never was too busy or too tired to do them a favor or to go far out of his way to help them in a more substantial manner. Many a man in the technical advertising field got their starts there through Bob Hume.

A few days before he was taken sick, he and one of his associates were on a business trip. It was late at night, and while they were sitting in the smoking compartment of the Pullman waiting for the porter to make up their berths, they discussed various matters, among them the mystery and purpose of life. Bob quoted the following lines from Sam Walter Foss' poem, as an indication of what he would like to do:

> "Let me live in a house by the side of the road and be a friend to Man."

And that characterizes Bob Hume better than 10,000 words could do it.

Those who knew Bob Hume intimately suffer in his passing a distinct personal loss; those who were brought in less close contact with him will grieve over the death of a kindly, thoughtful man. He leaves to his family the priceless heritage of a noble, useful, unselfish life.

Blasting Muskeg for Road Construction

A Method of Accomplishing a Difficult Undertaking by Means of Dynamite

By T. H. MICHELL
Technical Representative, E. I. du Pont de Nemours & Co., Inc.

In some of our northern states the building and maintenance of roads for the heavy highway transportation and travel which are characteristic of present-day life have been greatly hindered by muskeg swamps. These swamps or bogs develop generally from ponds or small lakes varying in diameter from two or three hundred feet up to several miles. The transformation from body of water to bog begins with the growth and partial decay of a fringe of plants around the border of the lake. The first fringe of plants to appear are usually pond weeds and water lilies and these are followed by bulrushes. As the vegetation flourishes and dies, season after season, a deposit of muck collects along the shore and, as it grows higher, the plants shift their position farther out toward the center of the lake. In the course of time, moss extends outward over the muck deposit, and later seedlings of several species of trees spring up, chiefly cedar, spruce and tamarack. As the muck becomes firmer it will support larger trees, and deciduous species, such as birch and ash, may partially replace the cedar, spruce and tamarack. In time, the lake completely fills up and the area becomes overgrown with small timber. Scattered through the layers of muck there may be trunks and tops of trees which were killed by high water or blown down, and even spruce, cedar and tamarack needles more or less altered.

Obviously such ground does not afford a firm foundation for a road, yet in some regions, where the muskeg swamps occur, it is impossible to lay out a road without having it cross one or more of these swamps. For secondary, lightly surfaced roads where no high-speed traffic is anticipated and where grades are of small consequence, a roadbed can generally be built on the muskeg with one or two feet of filling material which will hold up fairly well in use; but for a trunk highway to carry high-speed traffic where a minimum grade and good alignment are necessary, heavy filling is required, often from two to five feet above the surface of the swamp, and this is where serious trouble develops. The heavy filling causes the muskeg swamp slowly to settle, thus creating a sink hole which is a constant nuisance, if not a hazard, to fast-moving traffic. As this settling continues year after year, a great deal of work is required to keep these places up to grade and smooth, especially in the case of hard-surfaced roads, for the paving is often badly broken up by the settling, this being particularly true where the swampy places are short and of great depth.

A typical situation arose recently in the construction of what is known as the Trinity Road in St. Louis County, Minn., which is a road making connection with the paved state trunk highway No. 11 between Duluth and the Iron Ranges. The original plan was to grade the entire road and allow two years for it to settle before putting down the concrete pavement. In the course of grading over a muskeg swamp near the junction of the Trinity Road with No. 11 Highway, three sink holes developed. Borings made over these holes showed the depth of the muskeg to be from 9 feet to 33 feet, with the deepest sounding under the largest hole. The length of swamp measured longitudinally along the center line of the road was from 130 feet for the smallest hole to 240 feet for the largest, while, transversely, the greatest width was 500 feet. From 3 to 5 feet of filling material was placed over these holes to bring them up to grade.

The grading of this section of the road was completed in October. The next spring when the frost was out of the ground it was found that the roadbed had settled from .4 of a foot over the shallow sounding to 1.2 feet over the deepest sounding. From May to the following October there was very little settling. Knowing from experience that this settling during the winter months might go on for years, the contractors determined to experiment with blasting to see if they could speed up the process. Of course, merely exploding charges of dynamite in the muskeg would not have produced any positive result so the scheme tried was this: The sink holes were covered with filling material to a height of 3 feet above the grade originally established, making a total of from 5 to 8 feet above the natural surface of the swamp. Holes were then put down through the fill and the muskeg below to within 3 or 4 feet of the full depth of the sounding and these were loaded with dynamite and shot.

As the explosion pushed the muskeg out toward the sides, the gravel settled down and took its place. In some cases the settling amounted to 3 or 4 feet immediately after the blast. In twelve or fourteen hours the filling material was nearly out of sight. New material was then hauled and dumped into the sink holes until settling had apparently stopped. A few days after this, one of the engineers drove a plugged casing down to a depth of 28 feet over one of the 33-foot soundings, removed the plug and took a sample of the material at that depth. This proved to be the original filling material which had been placed on the surface during construction, showing that the muskeg had been displaced to a depth of 28 feet. At intervals throughout the next eight months readings were taken over the fills and the settling did not exceed .1 of a foot during that period. This seemed to indicate that blasting had accomplished within a few days a process of settling that would ordinarily require a minimum of seven or eight years.

The detailed procedure followed in putting down and loading holes was as follows: Some 2-inch pipe was cut into 7-foot lengths and both ends of each length were threaded so that the lengths could be put together with couplings. Dry oak plugs were cut 6 inches long and 3 inches in diameter. One end of the plug was then sharpened to a point and the other was cut down to fit snugly inside the casing. A plunger was made from solid steel 1½ inches in diameter and 6 feet long with an eyelet hole in one end. About 18 inches from this end a notch was cut on the two opposite sides of the pipe and a hole for a bolt was drilled through from notch to notch. Two flat pieces of steel about 4 inches long and of the same width as the notches were drilled through the center, fitted into the notches and bolted into place.

A wooden plug was placed in one end of one of the 7-foot lengths of pipe and a short piece of pipe was coupled on to the other end. A truck with derrick equipment was stationed so that the tackle block was directly over the spot where the hole was to be driven. The rope and chain running through the pulley were attached to the plunger and while one man held the casing in place two others on the truck drove it down by raising and dropping the plunger inside the pipe. When the 7-foot section was driven flush with the ground, the short length was removed and a new 7-foot length was joined to the first section, the holes being ultimately driven to within 3 or 4 feet of the depth of the sounding. If the filling material contained any rock or small boulders, the hole for the casing was started by first driving a piece of pointed steel. Holes were spaced on 25-foot centers, 3 rows of 7 holes each being driven for each blast. When the explosive was to be loaded immediately, the plug at the bottom of the casing was driven out while the derrick was still in place. This was accomplished by removing the two flat pieces of steel from the notches of the plunger and dropping it all the way to the bottom of the casing.

Each hole was sprung, using one cartridge of 40% gelatin and taking great care to seat it below the casing. After the springing shot, the casing was cleaned out with the tamping stick and 40% gelatin, 1¼ by 8 inches, was loaded by dropping one or two cartridges at a time. Occasionally trouble was encountered in getting cartridges down, but pouring water into the casing generally turned the trick. Charges ranged ordinarily from 20 to 30 cartridges in the shallow holes to from 50 to 75 pounds in the deep holes. In one hole over the 33-foot sounding, 350 pounds was loaded. Two electric blasting caps were used in each hole.

Effect of Street Widening on Value of Abutting and Adjoining Property

Results of a Questionnaire to Municipal and Private Engineers

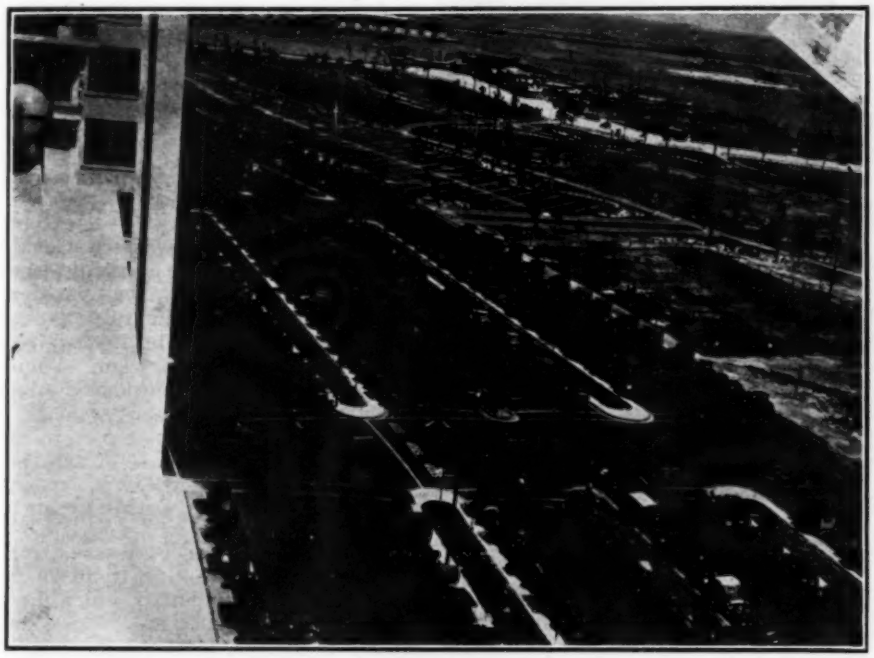


Fig. 1.—View of Biscayne Boulevard, Miami, Fla. This Boulevard Was Widened Several Years Ago to Provide Increased Parking Space. It Runs Along the Inner Bay with Large Hotels on One Side and a Park on the Other

HOW much does the widening of a street or the widening of city pavement affect the value of abutting and adjoining property? Well-authenticated information on this question grows more important as increasing numbers of cities resort to street-widening to meet a multiplying motor transportation.

To get such information, a survey among both municipal and private engineers was conducted. Returns showed that (1) in many cases records are not available over a sufficient period of years prior to the widening to give an accurate measure of its influence on property values; (2) that in other cases the necessary time has not elapsed since the widening to show what the full effects are; (3) that in many other instances factors, at present inseparable from the widening itself, have operated with it to produce a given result. These limitations, while preventing any graphical or tabular interpretation of the results as a whole, do not impair the worth of certain data that was obtainable, or present comparisons confined to a single city where differences in methods of levying taxes are presumably known to the man giving the figures.

Different Types of Development.—In a general way, the survey uncovered several distinctly different types of development that have been concurrent with or have followed closely major street-widenings. Some of these types are:

1. A stimulation of either business or residential growth on subdivided properties. This was noticeable where the widening made more or less of a main thoroughfare out of what had been simply a street. Stuyvesant Ave., Union County, New Jersey, is in part an illustration.
2. A change in the main use of the property from residential to business. Parts of Florence Ave., Los Angeles, are examples.
3. An increase in the desirability of business property, as such. Michigan Ave., Chicago, is an example.
4. An increase in the desirability of residence property as such. On this property apartment houses and apartment hotels replace to a large extent the single residence.
5. A radical change in the type of business conducted along a street. For an example, South Water Street, along the river in Chicago, long the province of wholesale produce-dealers, has by widening and double decking become Wacker Drive, lined by skyscrapers.

The survey also brought to light numerous examples of more specific information. Samples are presented here in three groups: (A) Comparisons between comparable widened and unwidened setreets where the depths of

Fig. 2.—View Taken May 7, 1927, Showing the Widening of 22nd St., Chicago

Fig. 3.—View of Old South Water St., Taken in 1925, Before the Street Was Widened

lots on the two streets compared do not differ by more than 10 ft.; (B) Similar comparisons where these depths differ by from 10 ft. to 50 ft.; (C) Opinions expressed where the engineer found his data insufficient or where he felt that any actual comparison that he might make would be misleading.

Street Fairly Comparable.—The following pairs of streets were judged fairly comparable before widening took place. The figures quoted are average tax values per front foot on lots differing no more than 10 ft. in depth.

New Haven, Conn.:

Property on Chapel Street, widened in 1920, was taxed at $400 per front foot in 1919 and $625 in 1927, an increase of 56 per cent. Property on George Street, an unwidened street given as comparable, was taxed $400 per front foot in 1919 and $425 in 1927, an increase of 6 per cent.

Milwaukee, Wis.:

Property on Oklahoma Avenue, widened from 66 ft. to 100 ft. on proceedings that began in 1915, was taxed $11.49 per front foot in 1919 and $42.05 in 1927, an increase of about 265 per cent. Manitoba Street, an unwidened street called comparable, showed an increase of 35 per cent in the same period.

St. Louis, Mo.:

Property on Seventh Street, widened from 60 ft. to 80 ft. in 1919, was taxed $85 per front foot in 1919 and $120 in 1927, an increase of about 41 per cent. Sixth Street, an unwidened comparable street, showed an increase of from $75 to $95 per front foot, or 27 per cent, in the same period.

Cleveland, O.:

Property on Superior Ave., widened from 50 ft. to 76 ft. in 1920, was taxed an average of $530 per front foot in 1920 and $1,279 in 1927, an increase of 141 per cent. Property on St. Clair Ave., unwidened street given as comparable, was taxed at $235 per front foot in 1920 and $328 in 1927, an increase of 40 per cent.

Streets Fairly Comparable Before Widening Took Place.—The following pairs of streets were judged fairly comparable before widening took place. The figures quoted are average tax values per front foot on lots differing from 10 ft. to 50 ft. in depth.

Chicago, Ill.:

Property on Wacker Drive (formerly South Water Street), widened and doubledecked in 1926, was assessed at $1,000 per front foot in 1919 and at $3,500 per front foot in 1927, an increase of 250 per cent. Market Street, an unwidened street also bordering the downtown district, was assessed at $1,300 per front foot in 1919 and at $1,500 in 1927, an increase of 15 per cent.

Charleston, W. Va.:

Property on Summers Street, widened from 45 ft. to 76 ft. (paving widened from 30 ft. to 46 ft.), was rated at $325 per front foot in 1919 and at $1,000 per front foot in 1927, an increase of about 207 per cent. Values on Capital Street, an unwidened street listed as fairly comparable, went from $1,500 to $2,000 per front foot in the same period or in increase of 33⅓ per cent.

Akron, O.:

Property on North Main Street, widened in 1922 from 50 ft. to 90 ft., was valued for tax purposes at $40 per front foot in 1919, at $26 in 1923 and at $60 in 1927, a total net increase of 50 per cent. Property on East Exchange Street, a comparable unwidened thoroughfare, was valued at $175 per front foot in 1919, at $120 in 1923 and at $124 in 1927, a total net decrease of about 30 per cent. The fall in tax values in 1923, according to the High-

Fig. 4.—View of New South Water St., Taken One Block Further South Than Fig. 3. There Has Been a 250 Per Cent Increase in Property Values in This Street Since 1920

way Engineer of Akron, was due to an arbitrary reduction by the county auditor, and the subsequent rise to reappraisal.

Baltimore:

In this case, depth of lots on the streets differed by more than 50 ft. after widening.

Property on Hillen Road, widened from 33 ft. to 120 ft. in 1923, was valued at $535 per front foot in 1919 and at $1,895 in 1927, an increase of about 254 per cent. Property on Falls Road, comparable unwidened street, went from $2,150 to $3,610 in the same eight years, the increase being about 68 per cent.

It will be noted in these samples, that in some cases the property values on widened streets exceed those on unwidened ones. In other cases the reverse is true, but in all cases the increase in tax value is greater on the widened than on the unwidened street.

Opinion by Various Officials.—The following are some of the opinions given by various officials. They are presented without any added comment.

District of Columbia:

"In the estimation of the Board of Assessors, all widening of streets and roadways has had a decided influence in increasing the values of abutting properties. The office could point to some cases where property values were more or less on a downward course and that such a tendency has been arrested by the widening and improving of roadways."—Wm. P. Richards, Assessor.

New Britain, Conn.:

"The only thoroughfare widened on which any data may be available is Chestnut Street widening just completed. No data as to increase or probable increase available. It is safe to assume the value of this street—centrally located—is due to increase. It is very probable that the widening will hurry this increase in value."—Thomas Linder, Chairman of Board of Assessors.

Flint, Mich.:

"We have had a number of cases where pavements were widened to accommodate business development along certain streets or portions of streets, on petition of the property owners. In these instances, the increased value of the property is apparent from the rapid development of the district."—Harry C. McClure, City Engineer.

Lakewood, O.:

"We have a small street-widening program in 1928, but no figures are available.

"On business streets unquestioned values are made because of increased accessibility. Our main thoroughfare, 66 ft. wide (paved 42 ft.), is too narrow to do business on. An 86-foot width with 56-foot paving would probably double the value of property in the business districts. Parking for shopping is the big problem in cities up to 100,000. (We now have a population of 65,000.)

"In business districts or projected business districts and along main traveled routes, street-widening for present and future traffic demands should show increased property values in excess of the cost of the improvement."—E. A. Fisher.

Winston-Salem, N. C.:

"We have several projects involving the widening of existing streets in the downtown districts which we propose to put through this year on petition of property owners. On one of these streets, the property owners have agreed to bear the entire cost of the project. There are four projects upon which property owners have agreed to pay 75 per cent on the cost of the work. In cases where the Board of Aldermen have instigated the widening of existing streets, the property owners pay only 50 per cent of the cost.

"As a general proposition, I would say without hesitancy that the widening of the street greatly increases the value of abutting and adjoining property."—Harry L. Shaner, Commissioner of Public Works.

Attention might also be called here to analysis of street widening in Los Angeles by John C. Shaw, City Engineer, Board of Public Works, Los Angeles, which appears in this issue of Roads and Streets.

It is only by the collection in the future of data as exact as is obtainable that the full influence of street-widening on property values can be obtained. In the light of the above and similar information, and in the absence of any contrary facts, it seems safe to generalize to the extent of saying that street widening or pavement widening not only makes traffic handling more efficient but that it decidedly profits the owners of property along and near the street improved; that furthermore, the increase in tax income following widening reinburses the city to a considerable extent for its share of the expesnse.

Highway Maintenance in Colorado.—On Feb. 1 the State Highway Department of Colorado took over all maintenance and reconstruction work on the federal aid or national highway system in Colorado. The same class of work on state roads, not included in the federal system, will be under the direct supervision of the county commissioners. The latter will have direct control over all expenditures on state roads for maintenance within their respective counties. On the federal aid system the state will have direct control of expenditures and will employ all maintenance patrols. At the same time the state will supervise the work done in ten counties having no federal aid roads and where the state will share the cost of maintenance on a "fifty-fifty" basis with the counties.

Power Equipment Cuts Maintenance Costs in Delaware County

The use of up to date equipment has made it possible for Sussex County, Delaware, to cut its maintenance costs in half and to do about four times as much, according to a report by Mr. Hill the County Engineer, presented at the recent convention of the American Road Builders Association. An extract from his report follows:

Sussex County, Delaware, has a large mileage of rural county highways. It has been necessary to turn to machinery and an organization to work throughout the year. Most of the machinery consists of one-man tractor graders, there being 22 of them. In addition there are one 10-ton tractor super mogul grader outfit, one 6-ton tractor Stockton 60 grader outfit, and 5-ton tractor super special grader outfit, and one 3-ton roller. With this outlay of machinery it has been possible to cut expenditures in half, and do about four times as much work. It was found that a good many of the one-man tractor grader outfits could do as much work for $7.50 as a team could for $32, the tractor being county owned and the team being hired from first one farm then another. Roads that were gone over with a scraper not over once a year are now gone over with scraper from 15 to 20 times a year. The big grader outfits have been used to widen and drain narrow roads at a fraction of the cost by the old method of team and labor. By the use of big graders grubbing is eliminated which makes a big saving. Instead of plowing all dirt roads are scarified thereby making another saving. A grader type of scarifier is used.

With the change over from team to machinery it was necessary to have a central shop to keep the machinery in repair. The county has a very up-to-date repair shop, well equipped, lighted and heated. All supplies, tools, and oils are bought at wholesale.

117,000 Mile of Highway on Snow Removal Program.—Reports received from the touring department of the American Automobile Association, show that more than 117,000 miles of highway are being cleared of snow and kept open to motor traffic this season. The roads making up the 117,109 miles to be cleared of snow are located in the thirty-six states which form the snow belt. The snow removal program of the states calls for the expenditure of more than $5,000,000 this winter. The average per mile cost will be about $45. The cost of clearing the highways of snow averaged $43.50 per mile last year and ranged from $6.40 per mile in Virginia, on the southern boundary of the snow belt to $136.62 per mile in Wyoming, in the northwest.

Utilization of Local Materials For Paving Work in Wisconsin

How the Plan Has Worked Out for Wisconsin Highway Department

By E. F. BEAN

State Geologist, Member Wisconsin Highway Commission

THE search for local sources of aggregate for concrete construction was started in 1920. The reasons for considering the use of local material were:

1. The fact that there is an abundance of well distributed gravel in that portion of the state in which concrete pavements were contemplated.
2. There seemed to be a reasonable possibility that considerable savings could be effected in freight, unloading charges, and truck haul.
3. There was at that time a shortage of cars which resulted in construction delays.

Methods of Geologist.—In a search for gravel a considerable knowledge of the local geology is desirable. The geologist is able to eliminate large areas from consideration and to concentrate upon more favorable ones. For this reason the work was delegated to geologists.

The geologist is assigned a definite project where construction is planned. In general a survey is made on each side of the proposed highway for a distance as great as that from the nearest railroad station (a source of rail hauled aggregate). If a siding is convenient the truck haul saving is not important, but the freight saving justifies an extensive survey. A larger area is covered if the alternative rail haul for commercial material is a great distance. Even in an area where good materials are known, a survey is necessary in order that the best deposit may be selected. The purpose of the search is to find the most satisfactory deposits when haul, operation cost, and quality of material are considered. The geologist has no supernatural powers. He knows what surface indications favor finding the particular material he is seeking and checks his conclusions with a shovel. No successful search for road material can be conducted without the investment of a generous amount of manual labor. Not only are all available exposures examined, but in the case of undeveloped deposits, test pits are dug just as in the exploration for iron ore or any other valuable mineral matter.

Notes.—Each deposit, both developed and undeveloped, is given a location number, and a complete set of notes recorded. This involves screen analysis, silt and colorimetric tests, a yardage estimate, amount of stripping, water supply, and length and character of haul. A sketch is made showing the location of the deposit.

The results of the geologist's investigation of each project are embodied in a report containing a brief description of each deposit and recommending certain deposits for consideration. Copies of the notes and of the report are sent to the materials engineer, the division engineer, and the county highway commissioner. The report and notes are supplemented by a mounted folded county map upon which is shown the area covered by each report and the location of each deposit covered in the report. These maps are brought up to date at least once a year.

Geological Party.—The geological party consists of a geologist with one or two assistants. A Ford roadster with pick up body is used for transportation. The equipment consists of long handled shovels, picks, bars, pails, screening and colorimetric-silt outfit. The average cost of the geologic work is about $30 per mile of project. This cost varies with the size for the project, the width of territory to be covered, and the amount of material available. As a rule the longer the project the less the average cost per mile. If railroad sidings are convenient and freight cost is low, a smaller area is covered. If material is abundant a wide area need not be covered, but considerable time is consumed in determining what deposits are worthy primary consideration. In some cases the work develops into a monotonous grind of eliminating all parts of an area. The stripping is too heavy, the quality poor, or the quantity too small to encourage development. But a negative report is valuable to the engineer as it tells him immediately that aggregate must come from an outside source.

The Materials Engineer.—The geological report is of no value at all unless this preliminary work is followed by thorough exploration. Wisconsin is fortunate in having a good follow-up organization consisting of the state materials engineer, nine division materials engineers, and the county highway commissioners.

It is planned now to complete all geological surveys one year, and in most cases two years, ahead of construction. During the progress of the survey the division materials engineer keeps in touch with the work. As soon as possible after receipt of the report, he begins more complete exploration of such deposits as are thought worthy of consideration. Sufficient test pits are dug to determine yardage, depth and character of gravel, as well as stripping. The probable savings are large enough to make this expense insignificant. Test pitting costs an average of about $3.00 per foot. Samples are sent to the laboratory for test. A sketch map is prepared for each deposit showing location of the test pits and the character of material exposed in each. This data is available for the contractor, who is also enabled to inspect the deposits considerably in advance of the letting. The deposit or deposits recommended for development are optioned in the name of the county. This option is assigned to the successful bidder.

Utilization of Local Material.—The contractor is required to meet specifications exactly the same as if the aggregate were coming from a commercial plant. This necessitates crushing, screening, and washing. From this standpoint there is no reason why the small plant cannot produce satisfactory material. In a given area the general character of the gravel is much the same in all pits, both local and commercial. The aggregate produced at the local pit is in many cases superior to rail-hauled aggregate in the following respects:

1. The coarse aggregate is better graded as there is less handling and consequently less chance for separation by sizes.

2. The moisture content is more uniform, because there is less time elapsed between the time when the material is washed and when it enters into the road.

From the quantity side there is little or no difficulty. During 1927 the local gravel plants were responsible for but little delay.

Financially, there is a direct saving by the use of local aggregate. These savings are as follows:

1. Freight. During 1927 the saving in freight on 94.29 miles of pavement built from local aggregate averaged $3150 per mile. In several districts the commercial plants could not have produced enough material to supply all projects under construction. This would have necessitated freight haul

from more distant plants, resulting in high paving cost for some projects if local material had not been used.

2. Unloading charge.

3. Saving in truck haul. Since many of the local pit projects were a long distance from the railroad, the bid price would have been much higher if only rail-hauled material had been considered.

The estimated savings on 94.29 miles of paving built from fourteen local plants in 1927 were as follows:

Freight	$296,764
Unloading	73,098
Truck haul	56,685
Total	$426,547

This is an average of about $4500 per mile of paving. Of course the state does not get the benefit of all this saving. A large or small proportion goes to the contractor, depending upon (1) the keenness of competition, (2) the impression the contractors get of the local deposit. If the deposit "looks good" to them their bids are likely to be lower. When the paving is done by efficient county crews, practically all of this saving reverts to the public.

Intangible Savings.—In addition to these direct savings there are intangible savings. In some cases, contractors planning to use rail-hauled aggregate have cut the price on other construction items in order to compete with local pit bidders. In some cases the price of commercial aggregate has been cut to meet the competition of local material. There results a saving even if local material is not used.

Up to the present time nearly all the local material employed has been gravel. As the paving work extends into regions where gravel is not available, local quarries will be developed. Many good limestone quarries have been opened to supply surfacing. These quarries will supply excellent concrete aggregate. In order that there be no delay in paving operations, it will be necessary to start quarrying and crushing considerably in advance of construction. The saving in freight and in truck haul will make this a very profitable enterprise.

Commercial Plants.—You are probably wondering how the commercial plants fit into this scheme. The purpose of material surveys is not to eliminate commercial plants. It is sound economy, however, to locate and develop local deposits whenever satisfactory aggregate can be delivered on the project at a cost lower than that for rail-hauled aggregate. The contractor who develops a local deposit is in fact operating a commercial plant. He chooses to use local material because he sees an oportunity to increase his total profit by an additional operation. He sells to the state the product of his plant rather than aggregate purchased from a regular commercial plant. With the usual keen competition, a part of the saving comes to the state. There is nothing to prevent the commercial producers entering the local plant field.

The following table shows the source of concrete aggregate since the material surveys have been well organized:

	Miles Total Built	Shipped Per Cent	Hauled from Commercial Plant Per Cent	Production Per Cent	Total not Shipped Per Cent
1921	345	57.6	24.8	17.6	42.4
1922	354	46.3	30.2	23.5	53.7
1923	431	58.8	14.8	26.4	41.2
1924	373	64.6	7.8	27.6	35.4
1925	154	66.6	3.4	30.	33.4
1926	215	69.5	10.4	20.1	30.5
1927	386	60.4	10.9	28.6	39.5

Acknowledgment.—This paper was delivered by the author, on January 26, during the annual meeting of the Conference of Mississippi Valley State Highway Commissioners.

Street Maintenance in Small City

Paper Presented at 14th Annual Purdue Road School

By CLAUDE DRAPER
City Engineer, Lafayette, Ind.

THE city gravel street has long been a source of worry to the city official in charge. It has been a big argument against the political party in control by the opposition at election times. If the wonderful promises made by the opposite party to make the streets smooth and level could be fulfilled our troubles would be at an end. But when the political party does get into control and they spend dollar after dollar trying to get the gravel streets into shape and then to see them full of holes and washed out they are indeed disappointed, as is the general public.

The street commissioner of a city has vastly different problems to meet in maintaining city streets than the county road superintendent. The county roads are supplied with plenty of metal and if dragged will be kept in fine condition but in the city the street commissioner has crossings, manholes and curb grades to contend with and in our particular city of Lafayette, with its hillside streets, if the street commissioner tried to keep an abundance of gravel on the streets he would have an endless job.

Every year in Lafayette approximately 8 miles of streets are oiled. This oiling has saved many of our hillside streets from washing, but oiling is like feminine beauty, it is only skin deep. Also oiled streets will soon become full of pot holes.

Filling Pot Holes with Oiled Gravel.—Our street department during the past season have been very successful by filling these pot holes with oiled gravel.

Early this spring road oil was mixed in the gravel and the holes were filled. We found that this pushed with the first auto traffic and was very disappointing, but our street department did not give up. They mixed up several yards of the material in the city yards and let it lay for several days.

The holes were next squared up, that is, the edges were made vertical and the loose dust was cleaned out. The oiled gravel was then deposited in the hole and well tamped into place with a hand tamp. Traffic was allowed to hit the patches and the next day the patches were again gone over and worked into place. It was found that after this careful method of fixing the potholes was completed it was very hard to distinguish the patch from the rest of the street.

This method of oiled gravel street repair can only be made when the potholes are caught in time. If the street is allowed to disintegrate until the holes are too numerous the only solution then is to scarify, drag, roll and re-oil.

Costs Should Be Kept.—In summing up maintenance of gravel city streets I would say that a cost sheet should be kept of each street and when this cost becomes high on account of heavy traffic then the street should be paved with hard surface pavement or the gravel surface treated according to its location.

It is, however, not always easy to pave the streets that most need it on account of politics; which is indeed unfortunate.

When streets are paved it should be the engineer's fight to see that wide widths are constructed.

It is my opinion that a narrow street is sometimes more expensive than the wider streets, because on the narrow streets the traffic must follow certain tracks, whereas on wider streets the traffic may be distributed.

Resurfacing Old Pavements with Rock Asphalt.—The paved streets also develop bad spots and must be repaired. In Lafayette we had several old brick and asphalt streets that were in very bad condition. One street in particular was almost impassible. This street was constructed of 2-course brick and connects the heart of our city to a one-time famous old brewery, and if any of you remember the volume of business this brewery did, you will realize the enormous pound and grind of these steel tired and heavily loaded beer wagons on this none too hard brick pavement. Also the street had been literally gutted with trenches on account of this digup and that digup until it was almost gone.

In 1921 a patch of rock asphalt was placed upon this street about 20 ft. wide and about 100 ft. long. In three years this patch had stood the traffic so well that it was decided to improve the whole street with this same material.

So in 1924 a contract was awarded for the resurfacing of Fourth St. from Main St. to Salem St., a total of seven blocks.

In the first two blocks the thickness

of rock asphalt was 1½ in. in the middle and 1 in. along the edge.

In the next few blocks the thickness of the rock asphalt was increased in the center until the last block where a total thickness of the rock asphalt was increased to 4 in.

This increase in thickness of the rock asphalt was made because the traffic had worn the old crown away and in some places the brick were three-fourths worn away. The rock asphalt was not laid the entire width of the old pavement; a strip of five feet along each side was not covered.

This saved the property owners considerable expense and also aided the crown.

It has been found that the edges of the rock asphalt have not ravelled and the street today is in fine condition.

There were several mistakes made in laying the rock asphalt on this job which have been eliminated in later jobs and are as follows.

The street crown should be built up with binder so that the rock asphalt can be laid on in a sheet of uniform thickness of not to exceed 1½ in.; also all holes or depressions on the street should be built up to grade at least thirty days before the rock asphalt is laid and given a good pounding by the traffic. On one street this year this patching was done so well and thoroughly that a committee of residents called and said that the resurfacing should not be made as their street was plenty satisfactory to them. Of course this was only part of the resurfacing.

In 1925 we laid two more jobs, Third and Fifth Sts., on old brick pavements.

In 1927 one block on South St., one block on Second St. and Sixth St. for about five blocks were resurfaced.

The Sixth St. and the Second St. resurfaces were made on old sheet asphalt surfaces.

The sheet asphalt was thoroughly cleaned by washing and scraping the deposits of oil that came from parked automobiles. The paint coat was then applied and the rock asphalt 1½ in. in thickness and 1 in. on the edge was then laid. Care should be taken in the resurfacing of asphalt streets to cut off all the bumps clear down to the base, as they are usually caused by shoving of the old binder. This should all be taken out and built up to grade with new binder. Care should also be taken to find all base failures before the resurface is made.

Costs.—The following is the cost per square yard of the work that has been done in Lafayette:

Street	Sq. Yd.	Cost per Sq. Yd.
4th	7,445.2	$1.40
3rd	1,698.6	1.44
5th	1,423.0	1.40
2nd	1,197.2	1.36
South	922.0	1.37
6th	6,495.5	1.38
Total	19,181.5	$1.39 1/6

We have used in Lafayette in the past two years about seven carloads of rock asphalt in street repair work.

Effect of Tire Chains on Pavements.—Rock asphalt has been used to advantage on our old asphalt streets that are now worn so thin that they soon break through with the use of steel chains on the auto tires during the snow period. It has been found by careful examination that these holes or breaks follow directly in the paths of the auto traffic and always show up just after the extended use of the chains on automobiles. Of course it is to be admitted that an auto without a chain on a snow laden street is a dangerous thing, but also our streets are to be protected and this hammer and grind of the non-skid chain is too much for them and if the use of these chains is allowed to continue it will cost the taxpayers thousands of dollars for the repair of our streets.

All our traffic on Main St. travels in the same tracks year in and year out.

There is no chance for it to deviate from these paths on account of a double car track and parked cars along the curbs. Every spring after the aforesaid tearing up by the auto chains, these paths or tracks were filled with numerous holes. The repair gang then have a job on their hands filling the cavities.

Repairs Along Street Railway Tracks.—This summer we tried to get the "jump" on the holes and in cooperation with the local street railway company we not only filled the holes but resurfaced between the tracks and about two or three feet on either side thereof. This resurface varies in thickness from ½ to 1½ in.

The space between the tracks and about 1 ft. outside the rail was taken care of by the street railway company and the balance by the city. During the resurfacing one side of a block was blocked at a time.

As soon as a section was rolled it was opened to traffic. This resurface has apparently adhered to the old pavement, which was of all descriptions, and to date the resurfacing is in excellent condition. About three carloads of material were required for the job and the expense was about equal to the city and street railway company. No account of the cost per square yard was taken due to the irregularity of the resurfacing. It is hoped that we now have a sufficient thickness of asphalt that will stand the pound of auto chains and that this spring no holes will appear.

The Importance of Competent Inspection.—In closing I might say that the best repairing we can do is at the time of construction, by having competent inspectors on the job.

Inspectors should not be given jobs to pay political debts and the engineer in charge should not tolerate such a practice.

About seven years ago an alley pavement was put in under one of these kind of inspectors. He was a good old party worker, but about all he knew about concrete construction was that it was to be a certain thickness. He let the contractor know that he was there to see that thickness was obtained. Each time the mixer moved ahead he had the workmen stretch a string from form-board to form-board and he would do the measuring, but on account of his inability to see good he failed to notice that the workmen held their fingers under the string. Whatever else that happened on this job is not known, but the alley has recently been repaired by the contractor after a litigation of two years' duration.

Instructions to Truck Drivers for Snow Removal

The following instructions, reprinted from California Highways and Public Works, were prepared by E. M. Shelton, one of the foremen of the State Highway Department, for the guidance of his men in snow removal work. They are based on his 5 years experience in this kind of work and apply particularly to snow removal by means of a Nash truck with snow plow attachment.

Operators should familiarize themselves with the road, so they will recognize the wide and narrow places when covered with snow.

Trucks should be allowed to warm up at least ten minutes before leaving shed. Be sure you have two red flags, one red lantern, and a tow cable or chain.

Adjust plow one-half inch above pavement. Always keep a slight strain on chain used to raise and lower plow. This is very essential for many reasons—it will not remove the asphalt, and helps the efficiency of the truck.

When snow is more than 4 in. deep, give blade all the angle possible. This will fold the snow instead of pushing it ahead, and thereby clear its way more quickly, and again help the truck. In depths under 4 in., blade may be almost square, as truck will handle it with ease, and you will have a greater width cleared.

Make all the speed possible with due regard to yourself, the truck and the traveling public. This is a great factor to be remembered, as it puts the snow from 2 to 8 ft. in the clear, and of course, you can get over more road. However, due precaution should be taken when passing or meeting cars, approaching stalled cars and bad curves, and other obstructions or dangerous points.

When pavement is not packed with frozen snow, always slow down for dangerous places in pavement and railroad crossings.

If snow is falling fast, do not stop to help anyone out, unless there are women and children or someone hurt, as you could do this all day and not get anywhere with your snow removal.

If, for any reason, you have to stop on bad curves or grades, send out flagmen at once. Do not wave flag violently, as the driver may become startled and get nervous and apply his brakes suddenly, which, on an icy road, might cause a serious accident.

When removing snow in cuts, with the bank near the pavement, keep center line of pavement about two feet to the left of end of plow, as you have no place to put the snow on that side, and ample room on the other. This will also help going up steep grades, as it will not put so much of a load on the truck the second trip, but will have more of a load coming down hill, which it will then handle easily. Likewise, on superelevations, keep to left of center line, when super is at your left. In other words, keep two feet past center line on super side.

Avoid getting truck off of pavement as much as posible, as shoulders are usually soft, and there is a very small clearance on the hook up beneath front axle.

Always put the rear end of truck off of the road when turning.

Do not put chains on unless you absolutely have to have them, as they shake the truck violently, and you can not make any time. However, at times chains are needed for a mile or so. Put them on when necessary, and take them off as soon as you get through the ice.

When you return to shed, never leave until you have first filled your truck with gas and oil and checked your lights, so truck will be in readiness for the next run.

Design and Cost Data On Creosoted Timber Bridges in New Mexico

Design and Construction Features of State Highway Department Structure

By E. B. VAN De GREYN

Bridge Engineer, New Mexico State Highway Department

PREVIOUS to 1925 the experience of the State of New Mexico with treated timber bridges was limited, being confined to creosoted piling in a few trestle bridges.

Since the beginning of 1925 many creosoted timber bridges have been constructed in New Mexico on Federal Aid Projects. In fact the total cost of all creosoted timber structures built since that time exceeds $1,000,000.

The First Creosoted Timber Bridge.—The first bridge built of creosoted material throughout was a trestle over the Rio Grande at Fort Selden on F. A. P. No. 107-A. It consisted of 9-31 ft. spans with 20-ft. roadway, the bents having 4-45 ft. piles per bent. This bridge had no surfacing on the floor and was designed for 10-ton truck loading. The creosoted timber trestle bridges since constructed have been built to provide the following:

1. Clear roadway of 19 ft. between felloe guards.
2. Gravel or crushed rock surfacing 6 in. thick at center of roadway and 4 in. thick at felloe guards. These thicknesses are for compacted surfacing.
3. Two 15-ton truck loading.
4. Woven wire guard fence attached to steel angle iron rails top and bottom.
5. Laminated or strip floors.

Most of our Federal Aid roads are surfaced with rock or gravel. In maintaining these roads the surfacing on bridges can be taken care of at the same time with the same equipment.

The woven wire guard fence has proved effective. The woven wire and the steel angle rails are painted white.

Cross sectional view of a panel of this type of trestle is shown in Fig. 1. This drawing shows also a framed timber bent with concrete base.

The laminated or strip floors are found preferable to plank floors as there is no springing of individual pieces under truck concentrations as in plank floors.

For our state road bridge, laminated floors are also employed. Where asphalt surfacing is used, the strip floor has given the best service. It was found that where asphalt surfacing was used on plank floors the spring of the planks under truck wheels broke the asphalt at the joints between the planks.

Reasons for Adoption of Creosoted Timber and Piles.—The cost of original construction of our bridges on Federal Aid Projects is divided between the State and the Bureau of Public Roads, on a basis of about 37 per cent and 63 per cent respectively. The maintenance after construction is borne by the State. Being a comparatively poor state and having a large number of stream crossings, it is therefore evident that in order to make our limited amount of money build as many bridges as possible and also have a low maintenance expense, the creosoted timber bridge was a natural choice.

The chief engineer of the A. T. & S. F. Ry. Co. informed us that the railroad figured a life of about 40 years for its creosoted structures and called attention to the necessity of cutting

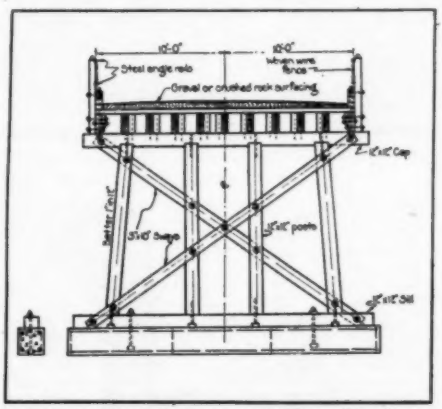


Fig. 1.—Typical Section of Floor Showing Framed Bent

and framing all timbers before they were creosoted. Framing of all members before treatment not only insures a better job of preserving, but is probably a saving in cost to both the state and the contractor, as in most cases such framing can be done more cheaply at the creosote works than in the field. A further saving is that of creosote oil as well as freight charges on the portions of the members thus cut away. An average bridge bill will suffer a reduction of 2 or 3 per cent in actual board measure due to framing and cutting to exact lengths.

There are many untreated timber trestle bridges in New Mexico. These trestles, generally built of native pine, soon rot; particularly the piles which decay at the ground line and at contact surfaces between the wood floor and tops of stringers. Considering the original cost of construction and life of structure, the cost per year of service of the creosoted structure would be not over 40 per cent of the cost of the untreated native timber structure.

Comparison of Cost of Treated and Untreated Structures.—Consider, for comparison, the cost of a creosoted timber bridge and an untreated timber bridge consisting of 3-21 ft. spans, 25-ft. piling, and with about a 4 or 5 ft. height of backfill at abutment:

The approximate contract price in New Mexico of such a creosoted pile and timber bridge, according to our standard, with 20-ft. roadway and designed for 15-ton truck would be $3314. The cost of surfacing, woven wire fence and steel angles for fence is not included in this estimate or in the estimate given below for untreated bridge.

The approximate contract price in New Mexico of a similar type bridge of untreated pile and untreated timber would be $2100. Portions of such a bridge rot out in a few years and need patching after such decay begins. The bridge will need replacing in ten years or less. Some of our untreated timber bridges built in 1921 are so badly rotted as to piles that they now need to be replaced. Considering only the cost of rebuilding the bridge and not taking into consideration the cost of maintenance during the ten years, we compare the real costs of the two bridges:

The average cost per year of the creosoted bridge would be $82.85, and of the untreated bridge $210.

Another comparison: The original cost of the creosoted bridge would be $3314, and it would last, say, 40 years. During the 40-year period it would be necessary to rebuild the untreated bridge three times, at a total cost of $8400, including the original cost. This indicates for the type of bridge being considered—creosoted bridge—a saving in 40 years of $5086.

For some of our state and county road bridges, lack of funds prohibits construction of creosoted material throughout. Where possible, in such bridges creosoted piles are used and all contact surfaces of untreated timber are painted with coats of hot creosote oil. Where inadequate funds do not permit the use of creosoted piles, all contact surfaces and the part of the piling most subject to rot are given liberal brush coats of hot creosote.

Design Basis.—In addition to dead loads, two 15-ton trucks with 80 per cent on rear wheels are used in design of stringers. The gauge of the truck wheels is taken at 6 ft. and the dis-

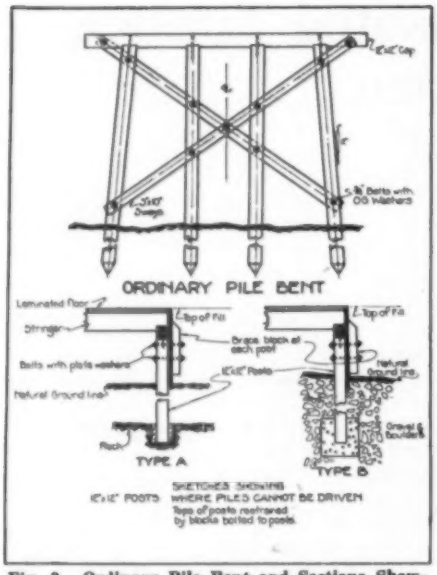


Fig. 2.—Ordinary Pile Bent and Sections Showing Filling of Posts

tance between axles at 14 ft. No impact is considered.

In the design of stringers the bending moments to be taken by interior and outside stringers are determined by the approximate method given in the "Standard Specification for Highway Bridges and Incidental Structures," of the American Association of State Highway Officials. Allowable unit working stresses per square inch for stringers, caps, etc., for our timber trestles follow closely those given in said specification.

In many of our old untreated pile bridges it was a common thing to find the top of the piling or the posts of abutments pushed in toward the stream by the earth against the bulkhead plank. In the case of high fills the piling was not capable of resisting the thrust. The same thing occurred even for fills of ordinary height where posts were set into the ground and backed with bulkhead plank. In the case of posts set into the ground, the depth of burial was not sufficient to enable the posts to furnish a resistance in bending. Therefore, in preparing designs for abutments where piles could not be driven and posts had to be set in gravel or rock the tops of the posts were braced by a timber block, as shown in Fig. 2. Sections A and B show the posts set in rock and in gravel. The block back of the bulkhead plank is held by bolts to the posts and plate washers provided. The thrust of earth is carried by these blocks to the ends of the stringers. In this design the stringer is dapped so that houlder bears directly against the cap. This close-fitting dap of stringer takes part of the thust from the block.

Occasionally we have a bridge where the height of fill at the abutment is too great to be taken care of by the ordinary abutment alone. In such cases a protection bulkhead of piling and plank has been placed in front of the regular timber and pile abutment and the space between the two filled with rock. The top of the protection bulkhead and rock fill is carried a little above the high-water level. Fig. 3 shows this style of construction. In this construction the stream flow is confined to the space between the two protection bulkheads. If used with a short length of bridge the protection bulkheads would consume a considerable portion of the waterway which would be a disadvantage.

Construction Features.—The contractor is furnished by the state with several sets of blue prints of detail lists of timbers needed for each bridge. These detail lists give the exact length of each timber and if the timber is a framed timber, the framing number is given. The framing number and the detail of framing for each timber to be framed are shown on our standard drawings.

The contractor furnishes the creosoting company with prints of timber lists and the framing diagrams so that all timber may be cut to length and framed before being creosoted. The state employs an engineer to inspect all materials before (including framing), during, and after treatment at the plant of the company furnishing the creosoted material. This inspector makes a report to the State on each treatment charge of timber or plling. Timber for our creosoted timber bridges is pressure creosoted 12 lb. per cubic foot of wood.

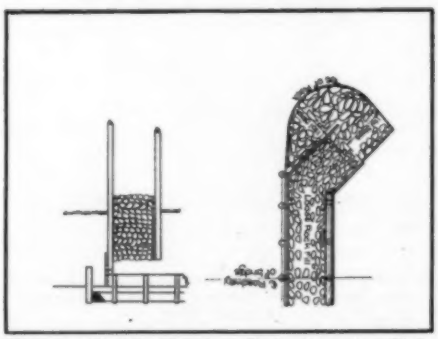


Fig. 3.—Sketch Showing Protection for High Fills

When timber is bored for bolts the holes are swabbed thoroughly with hot creosote oil. Since all holes are bored to a diameter at least one-sixteenth of and inch less than the diameter of the bolt, and as holes are treated with hot creosote oil, rotting at holes is not considered likely.

Our specifications regarding treatment of pile head read as follows:

"**Treatment of Pile Heads.**—After the necessary cutting has been done to receive the cap, the heads of treated piles shall be given 3 coats of hot creosote oil. They shall then be covered with a coat of hot tar pitch, over which shall be placed a sheet of 3-ply roofing felt or galvanized iron, or a covering may be built up of alternate layers of hot tar pitch and loose woven fabric similar to membrane waterproofing using four layers of pitch and three of fabric. The cover shall measure at least 6 in. more in each dimension than the diameter of the pile and shall be bent down over the pile and the edges fastened with large headed nails or secured by binding with galvanized wire."

As study of our creosoted timber bridges, already built and being built, shows the need, our drawings and specifications are modified.

Acknowledgment.—The above paper was presented at the second annual Highway Conference held at Boulder, Colo., Jan. 19 and 20, under the auspices of the Department of Civil Engineering and University of Colorado Extension Division.

$100,000,000 Collected from Gasoline Taxes in Six Months

Reports on gasoline taxes, compiled in the Bureau of Public Roads, United States Department of Agriculture, show that the District of Columbia and all but four of the States levied gasoline taxes in the first six months of this year ranging from 1 ct. to as high as 5 ct. a gallon. The total of taxes collected after allowing for refunds was slightly more than $100,000,000 collected from users of nearly 4,000,000,000 gal. of gasoline. The four States that did not tax gasoline—Illinois, Massachusetts, New York and New Jersey—are estimated to have consumed 947,000,000 gal., bringing the total gasoline consumption used for motor vehicles in the first six months to nearly 5,000,000,000 gal. New Jersey and Illinois went out of the taxless column when they imposed a 2 ct. tax effective July 1 and Aug. 1, respectively.

California, using more than 450,000,000 gal., had the largest gasoline tax receipts, more than $9,000,000, all of which went to state highway and local road funds. The other States with incomes of more than $5,000,000 were: Ohio, more than $7,500,000; Pennsylvania, more than $6,000,000; and Texas Florida and Michigan.

On June 30 Arkansas, Kentucky, New Mexico and South Carolina had the highest tax rates, 5 ct. a gallon, and on July 1, Florida increased her tax from 4 ct. to 5 ct. Nevada with $199,497 had the smallest receipts of all the States, although the Nevada tax is 4 ct. a gallon.

Construction and Lien Bonds for Contractors.—The Michigan State Highway Department has announced to highway road and bridge contractors that the department now requires surety bonds on all contracts, the face value of which is in excess of $10,000. This action was taken for the purpose of establishing a uniform basis for bidding on highway road and bridge projects, and to properly secure the construction and payment of lien claims.

26 Bids on One Job.—On one of the contracts for which bids were opened Feb. 28 by the Pennsylvania State Highway Department 26 bids were received. The job called for the construction of 40,756 ft. of concrete road.

Demonstration of Responsibility a Pre-Requisite For Securing a Highway Contract

A Paper Presented Jan. 10 at Convention of American Road Builders Association

By G. F. SCHLESINGER

Director Department of Highways and Public Works of Ohio

ALL public contracts of any size or importance can be entered into only after competitive bids are received. This, in general is the legal requirement of all our states, and of our federal government as well as many other governments, certain minor exceptions being made for emergency and small-sized projects. Highway contracts are no different in this respect from other public works contracts. Highway work, however, has been of such volume and is performed in such proximity to the public eye that both the official and contractor have been subjected to close public scrutiny in the procedure incideent to the award of a contract.

How Competitive Bidding Started.—The origin of the institution of competitive bidding on public contracts is unknown to the writer. Legal authorities say that it is probable that its inception was coincident with the substitution of constitutional for absolute monarchial government. The king's word was no longer law. Favorites could not be rewarded at public expense. The public official's actions, especially in financial dealings, should be controlled by statutory regulations. The purpose of requiring competitive bidding is so obvious that it needs little elaboration. It is founded on the principles that opportunity for graft on the part of either the official, the contractor, or both is removed; that all bidders have a fair field; and that the ultimate result will be of financial and general benefit to the taxpayers and citizens. While not fundamental law, competitive bidding to determine the lowest bidder is such a universal legal requirement on public work that it is looked upon by the general public as a basic principle of government. This fact should be borne in mind during this discussion.

The Primary Object.—The primary objective of competitive bidding is to determine the lowest bidder. At first this objective was the only one and, in many instances, is the only one today. Common sense and public good, however, required that the awarding authority should be given some discretion—that in some cases it would be bad public policy to give the contract to the lowest bidder. Hence most laws on the subject contain some such qualifying phraseology as "lowest responsible," "lowest competent," "lowest and best," etc. When the lowest bidder is defined in such terms the question arises as to the degree of discretion permitted the awarding official by the law. There are many court decisions that give the awarding official ample authority to use full discretion in determining the responsibility of the lowest bidder. In fact, it has been repeatedly held that it is not only his privilege but his duty to thoroughly investigate a bidder's qualifications before awarding him a contract.

The "Lowest Responsible" Bidder and the "Lowest and Best" Bidder.—A clear and concise statement interpreting the meaning of the terms "lowest responsible bidder," and "lowest and best" bidder and defining the rights and duties of the highway commssioner in making awards is contained in an official opinion rendered by the Honorable Edward C. Turner, Attorney General of Ohio, under date of Oct. 18, 1915. Replying to the request for advice by Highway Commisisoner Cowen, the Attorney General, after quoting several authorities, closes as follows:

"I therefore conclude, that as to the contracts about which you inquire, and which you are required to let to the lowest responsible bidder, you are not required under all circumstances to award such contracts to the lowest bidders, and are in fact not permitted to award such contracts to an irresponsible bidder. It is your power and duty in the letting of such contracts to look to the responsibility of the bidders, and in determining whether a bidder is responsible, you have a right to consider his pecuniary ability to perform the contract in question and his skill, experience, integrity and judgment. If, in the exercise of a sound discretion, you determine that the lowest bidder is not responsible, it is your right and duty to reject his bid and award the contract to the lowest responsible bidder, and in the absence of fraud or bad faith your decision upon a matter of this kind is final and not subject to review by the courts.

The term "lowest and best bidder" seems to be given somewhat wider meaning by the courts than the term "lowest responsible bidder," although the distinction between the meaning of the two terms is somewhat vague. In determining which of several bids is the lowest and best, you have a right to look to the pecuniary ability of bidders to perform the contract and to their skill, experience, integrity and judgment, and to any other similar consideration affecting their power to carry out a contract entered into by them and the probability of their being able to execute the contract in a workmanlike manner within such time as it may be proper to allow for the completion of the same.

Looking to all these considerations, it is your duty to determine which bid it would be for the best advantage of the state to accept, and the person filing that bid is to be regarded by you as the lowest and best bidder within the meaning of the statute and is to be awarded the contract. After you have exercised your discretion in determining which of several bidders is the lowest and best, the courts will not interfere with or review your decision in the absence of a showing of fraud or bad faith."*

Awarding Authority's Legal Rights.—There would seem to be no question as to the awarding authority's legal rights. However, the fact still remains that basically competitive bidding is predicated on the assumption that the lowest bidder will receive the contract. To most participants a road sale partakes of the nature of a sporting event and to use a figure of speech that would reflect this attitude, the horse under the wire first should not be disqualified except for good and sufficient cause. It is really a serious matter when an official decides to disregard fundamental principles and make the award to other than the lowest bidder. However, he is derelict in duty if he does not make a sincere effort to ascertain whether the advantage of having submitted the lowest bid is not outweighted by other qualities possessed by the lowest bidder that would cause him to be disqualified as the best or most responsible bidder. It goes without saying that if the facts warrant he should act accordingly.

*The new Ohio highway law that went into effect in January, 1928, changes the wording to "lowest competent and responsible bidder." It was undoubtedly the purpose to increase the discretionary power in making awards, but it is questionable whether it is possible to broaden the discretion beyond what is set forth in the above opinion.

Much could be said concerning the qualifications of an ideal, "Grade A," 100 per cent highway constructor. Without attempting to draw up detailed specifications for this hypothetical party of the second part the writer considers that he should possess the following attributes:

Character.—That a good character is the best asset a person can possess is true in the highway contracting industry as well as in any other line of business endeavor. A contractor who is honest, reliable and square can be forgiven many other short-comings. If he permits financial gain to blind him to a moral sense of right and wrong, his capabilities in other respects make him all the more undesirable. His shrewdness and alertness will make his dishonesty so difficult of detection that the results will be revealed only in the defective work that will show up some time after the final estimate is paid.

Financial Resources.—It is essential that the contractor have sufficient bank balance at all times so that bills may be paid promptly, discounts taken, modern equipment used, and labor payrolls met on time. No contract can proceed properly if the principal is being harassed continually by creditors, and the men are dissatisfied because they are not being paid promptly and

regularly for their services. Highway officials should realize that it is one of their most important duties to see that contractors receive their periodic estimates at such times as are specified in the contract. However the most desirable contractors will at all times have sufficient capital that an occasional delay in the receipt of an estimate will not affect the progress of the work. The contractor who has the finances will have the advantage in choice of competent employees and in the high morale of his entire personnel.

Experience.—Experience in the particular kind and size of work on which the contractor is bidding is highly desirable although not as essential as the first two qualifications just discussed. The excellence with which he organizes and manages a job is to a considerable extent dependent upon his having learned and profited by past experiences. The question of how a newcomer can break into the contracting business, if experience is necessary, is frequently asked. The answer is that experience on highway work is not an absolute requirement, especially on small contracts, if the bidder's reputation and record in other lines and his financial ability are satisfactory. It is a well known fact, however, that a boy must learn to walk before he can expect to compete successfully in the 220-yd. hurdles. In other words, it is usually disastrous to all concerned if the inexperienced contractor is given a large or difficult job before he has been tested out on the smaller and simpler projects.

Personal Ability.—This general term is used to express those qualities of mind and body that are desirable in an ideal contractor. Intelligence that will enable the contractor to understand the reasons for the requirements of the specifications, with enough technical knowledge to interpret plans, will prevent many a controversy with the engineer. Resourcefulness in meeting emergencies will be needed to reorganize a job to meet changing conditions. A knowledge of human nature, tact, broad mindedness and sense of fairness will promote a cooperative spirit in his own organization as well as with the engineer in charge. However, firmness in making decisions is necessary in order to command the respect of his men and associates. Mechanical aptitude and pride of workmanship are qualities that cause a good contractor to produce excellent results in spite of incompetent or lax supervision. Business men of the highest order is necessary to be successful in the highly competitive field of the highway construction industry.

An attempt has been made to describe the qualifications for which the awarding official should seek in a bidder on highway contracts. It is true that the ideal is unattainable but whenever the lowest bidder is in any degree undesirable the awarding official is confronted with the problem of analyzing the relative merits of all bidders in order that the award may be sound, just, and to the best interests of the public.

The Practice in Ohio.—About three years ago the Department of Highways of Ohio decided to require contractors bidding on highway improvement projects to submit with their bids a statement of their experience and financial qualifications. For this purpose the contractors were provided with forms to be filled in and sworn to before a notary public or other official authorized to take affidavits. About a year ago the forms then in use were supplanted by new blanks based upon the recommendations of the Joint Conference on Construction Practices for use in investigating the responsibility of bidders. This joint conference was composed of representatives of the highway officials, constructors, surety companies and other commercial interests connected with the contracting industry.

The forms in use at present consist of two in number: The first being titled "Experience Questionnaire and Financial Statement" and the second the "Plan and Equipment Questionnaire." There is only one Experience Questionnaire and Financial Statement required at each letting regardless of the number of projects on which the contractor is offering bids. The Plan and Equipment Questionnaire, however, is required for each proposal, the reason for which is obvious.

The following statement is included in the information furnished to bidders: "The information contained in the Financial Statement will not be made public, but will be returned to the bidder after the awards are made."

The state is entitled to full and complete information in order to intelligently determine the "lowest and best bidder." There have been instances where men have been low bidders on projects who have no equipment, little money, and less experience. Awarding contracts to men like this means only inferior work, delay, and the eventual "blow-up."

"The filing of financial statements and experience and equipment questionnaires will be mandatory, and failure to furnish these papers at a letting will be cause for rejection of the bid."

The Standard Questionnaires Used by 12 States.—According to Mr. W. R. Neel, State Highway Engineer of Georgia, and Chairman of the Commitee on Cooperation with Contractors of the American Association of State Highway Officials, standard questionnaires are being used in the following states: New Mexico, Florida, Pennsylvania, Ohio, Kentucky, Wisconsin, Missouri, Georgia, Nebraska, Iowa, Delaware and Illinois. Counties, municipalities, the Federal Government and private consulting engineers are also using the standard questionnaires approved and recommended by the Joint Conference on Construction Practices. The forms have been approved and are being used by members of the Clearing House Section of the American Bankers Association. The Financial Statement also serves to encourage intelligent bookkeeping among the contractors and to provide them with an up-to-date summary of their business status. Some highway departments require that bidders submit financial statements at stated periods to be kept on file in the department and revised from time to time. The practice in Ohio is based on the desire of both the Department and the contractors to keep at a minimum the likelihood of the statement becoming revealed to anyone but the awarding authority. We have never had a complaint on this score since the questionnaires have been in use in Ohio.

Advantages of Use of Questionnaire.—A detailed description of these questionnaires will not be given in this paper. The information requested is comprehensive and the result of most careful study by the members of the Joint Conference. It is not maintained that the use of the standard questionnaires will solve the problem of determining to whom the award should be made. It is believed that they are of the greatest aid to the awarding official in arriving at the correct decision. In many cases the contractor who is the lowest bidder is well known to the members of the department due to their experience with him in the past and the questionnaires are a formality. However, it frequently happens that newcomers appear as the lowest bidders and the question of their qualifications must be determined. It is usually not necessary to have a personal interview with the bidder if the forms are properly filled in although such an interview is desirable especially in the case of important projects. The contractor can be given a very searching quiz with the questionnaires submitted by him in the hands of the interviewer. If he states in his questionnaire that he has had experience in other localities his record can be checked up at once by letter or telegram. The main complaint and criticism we have received in connection with the use of these questionnaires is that in some cases the bidders have sworn to false statements. While this is undoubtedly true in exceptional instances it is also true that the guilty party is usually fooling no one but himself. If it obtained generally it would constitute an indictment of the entire highway contracting industry and not a condemnation of the use of the questionnaires. Other means of investigation are, of course, not precluded. In Ohio we receive a personal report and recommendation regarding the award from the Division Engineer in whose district the project is located. On all Federal Aid projects the Federal representative in the State is consulted be-

fore the award is made. A personal experience in awarding highway contracts in the amount of some thirty million dollars have made me a sincere advocate of the use of the standard questionnaires.

If there is doubt as to the responsibility of the lowest bidder it is then up to the awarding authority to decide, after a conscientious and complete investigation, whether he is justified in making the award to a higher bidder. The fact that a bidder can give a construction bond guaranteeing the successful completion of the contract should not be considered sufficient grounds for awarding him the contract if his bid happens to be lowest in price. It is not within the scope of this paper to discuss the surety bond question. It is a true and regrettable fact that many surety companies have furnished bonds to bidders thereby enabling them to receive contracts on which they proved to be dilatory or which they failed to complete. In Ohio 19 contracts amounting to about $1,500,000 have been forfeited since August 1925. In fairness to the surety companies it should be stated that in all cases they have completed the projects without additional expense to the state. However, needless to say, such projects have been greatly delayed in completion. The real financial loss has been to the traveling public which has been deprived of the use of the improved road. The cost of having to use a longer detour of a low type of surfacing assumes enormous proportions when converted into dollars and cents. The financial loss to friends and backers of the defaulting contractors whose claims were not protected by the terms of the bond has also been considerable. The entire highway industry has been injured beyond measure due to the inflated and automatic credit created for incompetent contractors by the surety bonds they should never have been able to secure.

Until 1925 a bidding bond was permitted in Ohio but the Legislature at that time enacted a law requiring that bidders on state road contracts be required to furnish certified checks with their bids. This law has been of great benefit in curtailing the undesirable bidder as, formerly, many bond agents distributed bidding bonds about as freely as their business cards.

Classifying Prospective Bidders in Wisconsin.—The Highway Commission of Wisconsin has avoided the necessity of ever awarding to other than the lowest bidder by adopting a policy of classifying prospective bidders according to the size of the project on which, in their opinion, they are qualified to bid. This is a form of restrictive competition or bidding by invitation and it is extermely doubtful whether it would meet the requirements of the law in Ohio and other states. The necessity of the awarding authorities exercising their discretion still exists—before the receipt of bids rather than after. There are advantages as well as disadvantages to the method, but the Wisconsin officials report it to be very satisfactory in actual practice.

During the present administration of the Department of Highways in Ohio, from August 1925 to December 1927, 34 contracts amounting to $1,298,423.76 have been awarded to other than the lowest bidder. This constitutes 6 per cent of the total number of contracts awarded in that period. In all cases the reasons for not awarding to the lowest bidders have been made a matter of official record on the journal of the department where it may be seen by all concerned. In some cases the reason consists of the fact that the department refused to waive clerical errors in the lowest bid. In others the journal contains a concise statement of why the lowest bidder was not considered qualified.

Why Contract Was Not Let to Lowest Bidder.—Following are examples of extracts from journal entries made in connection with the last two lettings:

"Contract awarded to———of ———, Ohio by grading roadway and paving with 5½ in. concrete base 1 in. sand cushion and 4 in. Hillside Brick at——— bid of ———, ——— County, ICH no. ———, Section ———. The bid of ——— of ———, Ohio, for ——— was not the lowest and best due to the unsatisfactory experience with this contractor with other contracts which he has had for the Department."

"Contract awarded to ——— of ———, Ohio, by grading and constructing drainage structures at bid of ———. The bid of ——— of ———, Ohio, at ——— was not considered the lowest and best because of the unsatisfoctry experience with ——— on previous and existing contracts."

To summarize a bidder who submits the lowest bid in competition should either be known to be responsible or caused to produce facts that will prove him to be responsible. It is accordingly, the duty of every awarding body or official to make as thorough and complete an investigation of the bidders as time and legal authority will permit. For this purpose the Standard questionnaires developed by the Joint Conference on Construction Practices will be found most useful. It is urged that all public agencies having the authority to award contracts adopt and use these questionnaires. In order to facilitate an exchange of information regarding bidders looking toward the ultimate establishment of a policy of rating contractors, a standardization of practice is most desirable.

The problem is one that cannot be solved by highway authorities alone. It is one that also vitally concerns the contractors, the surety companies, and all the commercial organizations providing materials, equipment and finances to the highway industry. In deciding the basic question of whom should be the man on the job digging the dirt or pouring the concrete, the highway official is entitled to and must have the sympathetic cooperation of the entire industry.

Classification of Contractors

How Wisconsin Determines Their Qualifications Described at Road School of State Highway Commission

By O. C. ROLLMAN
Construction Engineer, Wisconsin State Highway Commission

THE classification of contractors was first put into effect in Wisconsin in the beginning of 1925. The method used prior to this time was to let any one bid regardless of whether he had experience, equipment or finances. after opening bids, it had to be determined who was the lowest responsible bidder. In many cases the low man was not responsible and the award had to be made to the next bidder. This method caused a great deal of trouble and general dissatisfaction. When the low bidder was told he was not responsible he immediately went out and set up the claim to the public that the highway officials were not giving him a fair deal.

The Qualified List.—The idea of the qualification of all contractors for the kind and amount of work was to do away with having to reject the low bid. Under the classification method, the low bidder gets the job because he is not permitted to file a bid unless he is qualified to do the work bid upon. All notices to contractors for taking bids on work are as follows: "Bidders must be on qualified list for the type and quantity of work to be bid upon at least two days before the time set for opening bids."

It has been stated that the Wisconsin plan is a form of restrictive competition or bidding by invitation, and it is extremely doubtful whether it would meet the requirements of the laws in other states.

The object of compeitive bidding is to determine the lowest bidder. At first this was the only one, and in many instances, is the only one today, but common sense and public good, however, required that the awarding officials should be given some power in determining the responsibility of the lowest bidder. Therefore, most laws state that the award shall be made to the lowest responsible bidder. The awarding official must, therefore, determine the responsibility of the bidder either before or after taking the bids, and the Wisconsin plan is to do this before taking bids.

Performance Record of Contractor.—

The information that is filed by the division offices on each contract job gives the main office a record of the performance by the contractor. This record takes into consideration the following: The name of the contractor; the name of the job; length of the job; total amount of the contract in dollars; date of the letting; date of the contracts date of the final approval of the contract; agreed upon date of starting the work; agreed upon date of completion; final estimate in dollars; date of final acceptance; loss of time due to weather; loss of time due to conditions beyond the control of the contractor; loss of time due to the contractor's fault; the number of working days; the total construction units; the average number of construction units per working day; the progress, whether normal, subnormal or unusually rapid; what part of the work was sublet; the name of the subcontractor and his address; general progress, whether excellent, good, fair or poor; whether the job was properly financed, equipped, organized and managed; whether the contractor paid his bills promptly, delinquent, or whether there were claims filed against the job; what attitude the contractor took toward final settlement; whether the engineer had trouble or made final settlement very easy; the general attitude of the contractor towards the work, whether he was cooperative, agreeable or antagonistic.

Classification of Contractor.—After taking into consideration all of these items mentioned on the different classes of work, as grading, structures, paving or surfacing, the recommendation of the division engineer is to place the contractor in one of the following classifications: General contractor; grading or surfacing; grading only; surfacing only; bridges, concrete, timber or steel small structures; and paving only. The classification provides for other work that may be included in the contract and a maximum amount in dollars that he will be allowed to have under contract.

A general contractor is one that can bid on any one or all of the classifications, but he is limited to the amount of work under any one classification. For example, the general contractor may be permitted to bid on bridges up to a certain amount in money or a certain size. If, for any reason, there is a larger bridge included in the contract which he is not qualified to build, he must agree to sublet this bridge to some qualified contractor. The maximum amount of the contract will always be limited. In other words, we may have a general contractor who can have a bridge included in his contract up to $30,000, or a certain length in span, but his total amount of work that can be under contract will be limited to $200,000. A grading and surfacing contractor is one that can bid on grading and gravel or stone surfacing and structures up to a certain size, with a limit to the size of his contract in dollars, and the same for the other classifications.

As stated before, the division engineer fills out the report for each job, and makes his recommendation on a form provided. The main office checks the information. Where there is a contractor that more than one division engineer reports on, the main office takes into consideration the recommendations of all of the reports for the same contractor and gives him a rating. When a contractor has had a previous rating the report may show an increase or decrease, or may contain a recommendation for taking him off the qualified list altogether. The recommendations made by the division engineer are passed on by a main office committee which is composed of the deputy state highway engineer, the chief accountant and the construction engineer.

The Questionnaires.—All contractors who wish to be placed on the qualified list must file with the main office an equipment, financial and experience questionnaire. The equipment questionnaire will show a list of the equipmen on hand and available for use. The financial questionnaire will show the total assets and liabilities and net worth; also the bank or bankers given as references, and the amount of credit the bank or bankers will extend; whether or not the contractor has ever been insolvent or bankrupt or failed to complete a contract on account of lack of finances.

In the experience questionnaire the contractor must state his experience in highway construction as a general contractor or subcontractor; the type of construction mostly engaged in; as to whether or not the contractor has ever done any work for the U. S. Government; what state highway department he has ever worked for; what county highway department; what city he has ever worked for; or what corporation or individual; the largest contract he has ever had and the location, giving in detail the type of construction; whether or not he has ever failed to complete a contract that was awarded to him; whether or not he has a going organization, and if not, how soon he could effect one.

System Has Worked Out Well.—In general, the qualification of the contrators has worked out very well and we have had little or no trouble in handling the matter. There is, of course, the tendency on the part of many contractors to get as high a rating as they possibly can, and we, no doubt, have contractors on our list for more work than they can handle. We also find that in some cases the contractor will handle a job in a very efficient manner in one season and in the next something will happen to upset his whole arrangement and he will not make anywhere near the progress he did the season before. However, our rating is adjusted from year to year, and in that way all matters can be taken care of. In other words, a man's rating may be up to $200,000 at the end of one season and by the end of another this rating may be cut down to $100,000.

We have tried to keep the information as to the rating of the contractors confidential. It is not the idea that this information should be broadcasted. If a contractor files a bid on a job that he is not qualified to do, this is discovered before the bids are opened and his bid is not read. Later the bid is handed back to the contractor and he is told the reason we did not read his bid, and there is no publicity given to the fact that the contractor was not qualified to do the work.

Use of Cotton Fabric in Highway Construction

A new cotton fabric designed for use in highway construction has been perfected as a result of research conducted by The Cotton-Textile Institute, according to an announcement of Ernest C. Morse in charge of the New Uses Section.

This new fabric was developed in the experimental cotton mill in the Bureau of Standards in Washington by the A. A. Mercier Research Associate of the Institute, on specifications devised by F. R. McGowan, Textile Engineer on the staff of the Institute. Samples have been submitted to highway engineers, Mr. Morse stated, and one engineering firm has already asked for bids on 300,000 yd. of the material.

The new fabric is a loose cotton mesh for use in the construction of concrete highways. It is laid over a cement base and on top of the fabric the surface of the roadway is molded. The layer of fabric is stated to serve as a cleavage between the surface of the road and the foundation so that in case of repair the top layer of roadway may be removed and a new surface installed without impairing the more permanent foundation.

It is expected that at least a million yards of the fabric will be consumed this year.

Over 3,500,000 Motor Vehicles Made in 1927.—A total of 3,530,000 cars and trucks were manufactured in 1927, having an aggregate wholesale value of $2,556,750,000 according to figures compiled by the National Automobile Chamber of Commerce.

23, 125,000 Motor Vehicles Registered in 1927.—Automobile registration during 1927, totaled 23,125,000 cars and trucks according to figures compiled by the National Automobile Chamber of Commerce. Comparing the registration to the miles of surfaced highways, the figures show that there are 40.2 cars and trucks in the United States for every mile of surfaced road.

Tar Surface Treatments of Sandy Gravel Roads

Methods of Treating Low Grade Gravel Roads

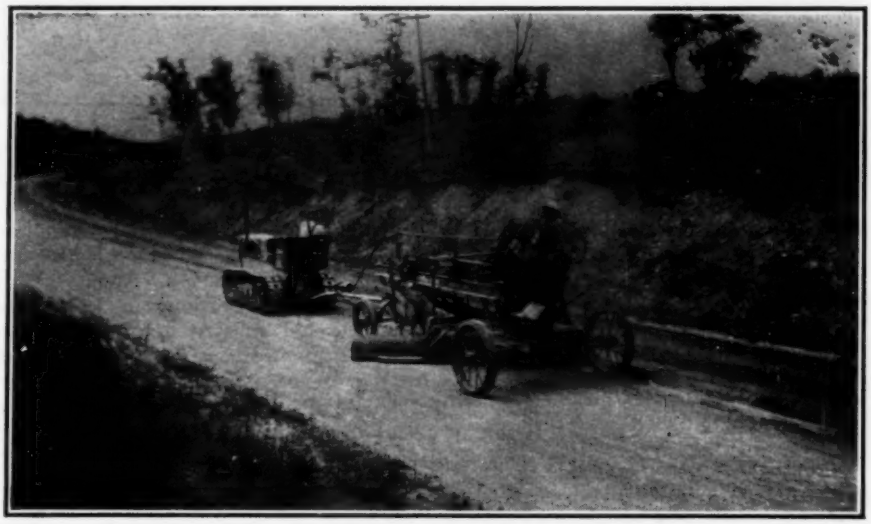
By GEO. E. MARTIN
Consulting Engineer, General Tarvia Department, The Barrett Co.

ROADS built of gravel containing an appreciable percentage of pebbles above ¼ in. in size have been successfully treated with tar in various sections of the country for a number of years. Until recently, however, this work has been confined to high quality gravels, and the sandy gravels or those containing a large percentage of small pebbles have generally not been treated with tar.

The reasons for the surface treatment of sandy gravels are the same ones which lead to that work on ordinary gravels. With a small number of light vehicles, the sandy gravel roads give good traffic service. However, their economic and efficient traffic limit is soon reached. Three or four hundred vehicles per day will tear the binding material out of the road surface, raise clouds of dust, and cause a rapid wearing away of the surfacing material. As the traffic increases the maintenance costs go up. It has been determined that the maintenance costs on untreated gravel roads of this sort increase directly with the traffic and will be about one dollar per mile per year for each vehicle over the road in an average traffic day of 24 hours. In other words, if a sandy gravel road carries an average daily traffic of 1,000 vehicles, the annual maintenance cost will be about $1,000 per mile. In this cost is included the expense of grading or dragging the loose material on the road and that of supplying new gravel to replace that blown away and thrown off the road. Excessive dust makes the highway more dangerous since it is difficult to see through the dust cloud.

What Experiences in Minnesota Have Shown.—Experience in Minnesota during the past few years has demonstrated that it is possible to successfully treat these sandy gravel roads with "Tarvia-B." Gravel containing as little as 6 per cent of material retained on the quarter inch sieve has been so treated. Tar surface treatments will firmly bind the particles of gravel together and absolutely eliminate dust and loose material from the road surface. The change from a loose, shifting surface to a firmly bound one makes grading or dragging of the finished surface unnecessary. The dusty gravel highway is changed into an easy riding, non-skid, safe road at a fraction of the cost necessary to pave it.

Early treatments in Minnesota developed the fact that the mixed-in-place or mulch method of treatment used in the middle west was satisfactory, but it was necessary to devise modifications to meet the special conditions.



Grading Loose Gravel into Center of Road

Method of Treating Sandy Gravels With Tar.—The following method is now generally used in treating sandy gravels with tar:

First.—With a heavy blade grader, windrow all of the loose material from one side of the road into the center of the road. All of the loose material must be removed and a solid base obtained. Ridges formed by the blade jumping should be scraped into the center of the road with a square nosed shovel or other similar device.

Second.—Apply on the solid surface exposed approximately ⅓ gal. per square yard of "Tarvia-B." The exact amount of tar will depend upon the subgrade material. Clay will take somewhat less than ⅓ gal. per square yard and sand somewhat more. The road should have as much as it will take without having tar running off.

This first application of tar is allowed to set up and may be subjected to some traffic. Holes which may appear in the treated surface should be patched with a mixture of "Tarvia-B" and gravel using about 17 gal. of "Tarvia-B" to a cubic yard of gravel.

An interval of 24 hours or more should elapse between the first and second coats of tar.

Third.—Apply approximately ⅓ gal. per square yard of "Tarvia-B" on top of the previous application and move the loose material from the windrow in the center of the road immediately over the wet tar. This work is done best with a 10 or 12 ft. blade grader. Smooth the layer of loose material out over the treated portion of the road.

Fourth.—Move the loose material from the untreated side of the road into a center windrow.

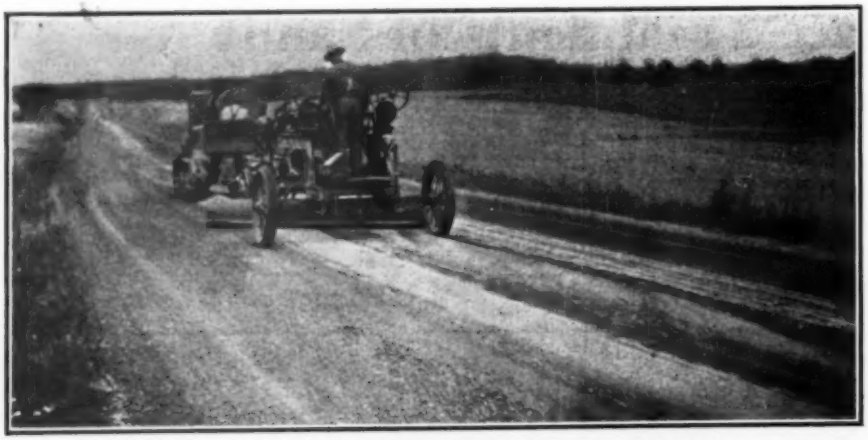
Fifth.—Treat the solid portion of the road thus exposed with "Tarvia-B" as in step two and allow to set up.

Sixth.—Apply second coat of "Tarvia-B" and spread loose material over the wet tar.

Seventh.—With a blade grader keep the loose material smoothed out over the road width. The blade is set just high enough to agitate the loose gravel on the surface barely touching the tar. In this way the road surface is brought to a good cross-section. By moving the gravel back and forth, all of the particles become coated and finally held in place by the tar.

This work is continued until the tar begins to set up. As soon as the blade begins to pull the surface, the road is completed, and no further work is required with the blade.

One of the main advantages of this method of treatment is that the proper amount of tar in the surface mulch is easily obtained. If a spot shows too much tar additional dry gravel can be added. If too much loose gravel is



Smoothing Surface for Surface Treatment of Sandy Gravel Roads

present it will be whipped off by the traffic and the gravel underneath will be bound together by the tar.

A recent modification of the method has been to lightly spray the windrow of untreated gravel with "Tarvia-B" before it is smoothed out with the grader. This coats the particles of gravel and holds the larger particles in places on the road surface.

After the road is treated it is placed under patrol maintenance. Because of varying quality and thickness of gravel, breaks may occur in the surface and these should be repaired at once with the tar-sand mixture.

This method of treatment with the subsequent maintenance costs from $1,200 to $1,800 per mile for a 24-ft. road for the first year. Subsequent costs are always considerably less because even if a surface treatment is necessary, less tar will be needed than on the original treatment.

Where the road breaks to any extent in the spring it has been found advisable to scarify it before re-treating. A grader with a scarifier attachment has been successfully used for this work, and it is general practice to scarify and reshape a mile of road per day. The road is then re-treated using less tar since there is a considerable amount retained in the gravel. About 5 per cent of the work done in 1926 was scarified and re-treated in the spring of 1927. Forty-five per cent was patched and re-treated. Fifty per cent of the 1926 work went through the 1927 season without a surface treatment.

These methods of treating low grade gravel roads have opened up new possibilities in rural highway service. Light truck and passenger car traffic continues to increase even on local roads. Tar surface treated gravel produces a road which will easily carry 1,500 to 2,000 light trucks and automobiles per day. Very few roads except main traffic routes in the vicinity of large cities carry more than 2,000 vehicles per day. The residents along the road as well as the passengers on the road are relieved of the dust nuisance. A low cost road of this sort makes satisfactory traffic service available now to many communities which cannot afford to pave all of their highways.

Applying Tar and Moving Loose Gravel Over It

Bridge and Culvert Maintenance

Equipment Used by Iowa County Described in Report at American Road Builders Association Convention

By JAMES O. McLEAN
County Engineer, Sioux City, Ia.

THE selection of bridge and culvert maintenance equipment is a phase of the equipment problem that has perhaps not been given the consideration that its importance warrants. Too frequently our highways are considered as so many miles of paving, gravel or earth road as the case may be, and an equipment schedule worked out for their upkeep, with little or no attention given to the drainage structures. There is perhaps no part of the highway that requires more frequent inspection, than the waterways and it is essential that provision be made for their maintenance with equipment that will prove satisfactory.

Bridge and culvert maintenance equipment can be considered under two headings:

1. Equipment for the maintenance of permanent bridges and culverts.
2. Equipment for the maintenance of temporary bridges and culverts.

In considering the first of these divisions, permanent structures: on these there is a veriety of maintenance work occurring with more or less regularity, requiring special equipment which unless provision were made for it, would be difficult to obtain.

Concreting Operations. — Waterways in many cases are deepening and widening requiring the extension of existing concrete culverts, construction of aprons, building of protecting curtain walls on abutments that are being undermined, repairing concrete rails that are destroyed by collisions, all require that we must provide ourselves with equipment suitable for the mixing and placing of concrete in comparatively small quantities. A batch mixer, preferably of 1 sack capacity is well suited for this work, which with the engine, should be mounted on trucks so that it will be readily portable. A loading skip, while it will increase the initial cost of the mixer somewhat, will more than pay for itself if there is any considerable amount of work to do. As auxiliary equipment for our concreting operations, there will be required a light truck of a ton to a ton and a half capacity, which should be equipped with dump body for hauling aggregates, cement and other supplies needed; a water tank also mounted on wheels, bar cutter and bender, shovels, picks, spades and small tools.

There will at times be concrete work to do of a heavy nature for which the above equipment would not be adapted; these jobs are the exception

and not the rule and can better be let out at contract than handled by the regular maintenance crews.

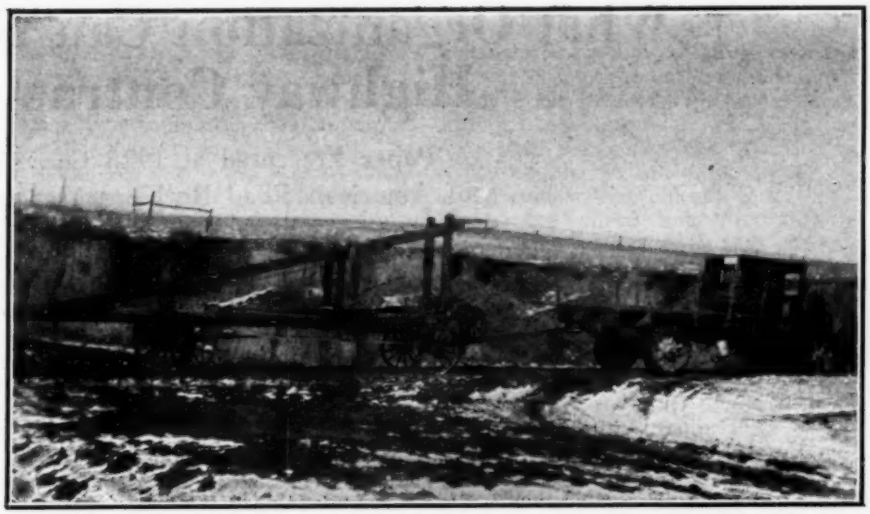
Painting Structures.—Where structural steel is used in combination with concrete and portions of the metal exposed to the elements, painting will be necesary at intervals of five to eight years. Due to the infrequency of this operation equipment for handling it would be acquired perhaps just prior to its use, such as steel brushes, metal scrapers, painter's torch and if need be, a sand blast for preparing the metal. Brushes for applying the paint should preferably be of the round variety, of ample size, including a brush or two with long handles so that the more inacessable places may be readily reached.

The higher structures will require hooks, block and tackle and a scaffold for work on the trusses and floor system.

Maintaining Bridge Floors.—Concrete floors on permanent bridges require little attention other than making provision for equipment to handle the expansion joints. When covered with bituminous mat coating or asphalt wearing surface, the selection of special equipment again becomes desirable.

In handling any of the tar products for maintenance work, a small 2-wheeled kettle of 110 gal. (2 bbl.) capacity is well suited, equipped with fire box for wood burning, of the portable type, so built that it can be readily moved from place to place. A light truck will also have to be availabe with this outfit, for transporting tools, tar, aggregate and hauling the kettle. Supplemental equipment will include pouring pots preferably of the narrow deep variety, so built that they will retain the heat, a small hand roller or as a substitute tampers, rakes, square pointed shovels and hand tools.

Equipment for the repair of an asphalt wearing surface should also be of the portable variety, mounted on wheels and equipped with oil burners. Provision should be made for heating the asphalt and aggregate in separate compartments, with the mixing done by hand. This should be accompanied with a portable tool heater of the oil burning variety and light truck for hauling the materials and heaters, together with the small tools such as tampers, rakes, picks, shovels, brooms and squeegees.



Portable Pile Driver Mounted on Wheels and Pulled by Truck

Equipment for Temporary Repair.—A part of the equipment heretofore specified for maintenance work on permanent bridges is also suitable for use on temporary structures, such as the painting equipment and equipment for repairing bituminous mat and asphalt wearing coats.

In addition, the temporary structures will require a full set of the usual bridge repair tools such as drills, jacks, saws, crow bars, sledges, axes, shovels, picks, etc., which, due to their variety and bulkiness, should be kept in a special tool box built for the purpose, mounted on wheels so that it can be pulled from place to place. A heavy truck of from 2 to 3-ton capacity should also be supplied for hauling timbers, plank and piling. A pile driver with leads from 24 to 30 ft. long and hammer weighing from 1,200 to 1.600 lb. will complete the outfit.

This equipment will handle the ordinary bridge maintenance work such as repairs to wings, floors, pile driving and the addition of approach spans. Work heavier than this, it is assumed, will be contracted.

Special Tool Box for Carrying Bridge Repair Tools

Taxation Rates for Busses.—"Maintenance of Way Charges Against Public Carrier Busses" is the title of a 32 page bulletin (No. 85) just published by the Iowa Engineering Experiment Station. The bulletin presents data on the rates of taxation applied to common carrier busses in Michigan and Iowa and deals with the equitableness of the bus tax systems in the two states, particularly in comparison with the taxes imposed on the automobile. An analysis of the sums that will be required for highway purposes is included to indicate whether present rates of taxation on motor vehicles are likely to provide sufficient funds. Copies of Bulletin 85 may be secured by addressing the Engineering Experiment Station, Iowa State College, Ames, Ia.

Dallas, Tex., to Spend $23,900,000 for Improvements.—The city of Dallas, Tex., has approved a plan for civic improvements and authorized bonds to be issued to the amount of $23,900,000 to finance the plan. The program contemplates a nine year building program, and the bonds are to be issued over this period of time. It will be unnecessary to raise the tax rate to finance the undertaking, since it is planned to raise the debt levy by an increase in property valuation from 50 per cent to 58 per cent. Among the projects are street opening and widening work to cost $5,700,000 and street paving (city's share) $3,000,000.

What Organization Can Do For the Highway Contractor

A Paper Presented at 1928 Convention of American Road Builders Association

By A. H. HUNTER
Engineer, Illinois Association of Highway and Municipal Contractors

Cycles of prosperity and distress have marked the highway industry just as they have alternated in every other productive activity. It is in these periods of depression that we find individuals most interested in the affairs of their trade association. Their needs at such times being greater they naturally turn to group activity in hope that by organization they can secure improvement of conditions. The records of the Illinois Association of Highway and Municipal Contractors over 21 years of continuous existence is only a story of the fluctuating fortunes of the individual members. The value of this association for promotion, education and service may be reflected in the assistance rendered to the individuals in this group of contractors.

Early Day Promotion of Municipal Work.—Previous to the day of highway development, the promotion of municipal work was in the hands of individuals who confined their efforts to their own or neighboring cities. In winter months new work was promoted and each contractor assumed the responsibility of his own prospective activity. At the beginning of highway construction many contractors were recruited from the municipal ranks. After a time municipal promotion was neglected and interest centered around the programs of the state highway department. As long as the volume of work increased conditions were satisfactory, but at the least cessation of active operations competition developed. Prices on highway paving were reduced to an unprofitable condition. Municipal paving also became unattractive. Apparently the municipal contractors had lost both the art and the inclination for promoting work. The creation of municipal work today affords many opportunities for those with experience or ability along that line. Our association with finances and personnel limited cannot hope to be of direct service. We can exert an indirect service by assisting in the standardization of specifications and construction practices.

Bond issues for public highways, totalling $160,000,000, have in the past years been promoted in Illinois. Our association contributed in time and funds to the necessary advertising. Individual members gave freely to the support of a program which afforded them construction opportunities. Recent legislation in the form of a gas tax was supported by our organization. An annual income from this source, estimated at from $12,000,000 to $15,000,000, will be available for highway purposes. While not as large as the bond issues, it has the advantage of uniform continuance amounts. We believe the passage of this law will do much to stabilize the industry in Illinois.

Educating Contractors in Construction Costs.—Previous to our annual convention in 1926, the board of directors of our association met and decided on an intensive program of education on construction costs. The board was convinced that many bidders on public work had no sound basis for estimating. Nor did this apply to contractors in general. Apparently some of our own members were as ignorant of conditions as anyone else. Accordingly, the entire convention program of 1926 was devoted to an intensive study of construction costs. Speakers were selected and were assigned definite subjects with natural divisions of the work. As an illustration, one contractor had the subject of truck hauling. He presented it in the form of a paper supplemented with charts showing hauling costs with privately owned trucks. The data arranged included five separate sections of state highway work, totaling 50 miles of 6-in. 18-ft. standard concrete pavement. This work had involved four seasons, with hauling accomplished under varying conditions found on country paving in our state. We are convinced that this record of transportation costs is one of the most reliable in existence.

To stimulate thought and invite discussion from the floor of the convention a typical estimate was prepared based on average conditions. This estimate, worked on separate sheets, was placed in the hands of those in attendance. The arrangemnet of this data laid special emphasis on equipment, finances and general expense or the indirect costs of construction.

The attendance and interest shown far exceeded any previous convention experience. Following the convention we had requests for papers and data from contractors representing most of the states in the Mississippi valley. Probably we did nothing that could not have been accomplished by any other association. Perhaps others could have done better. However, we are convinced that we struck upon a very important subject—the education of the contractor.

In the summer of 1927 short articles on Depreciation and Obsolescence, Contractors' Financial Requirements and other subjects covered in the original estimate presented at the convention were published in our magazine, Public Construction News. It is our intention to present a complete printed discussion of the entire estimate. As yet the magazine articles are incomplete.

The Engineer.—Now a word in regard to the engineer. We believe that the engineers in responsible charge of construction have a sound and fair idea as to those items that comprise the cost of any piece of work we may have to conduct. They are as honest and conscientious as any group of men with whom we hope to do business. At the same time subordinates in the field are not so well advised. Resident engineers and inspectors frequently create false impressions as regards the profits accruing to the contractors. Construction costs is a hobby with most engineers. They can determine the direct expenses but unless they have maturity of judgment gained through time and experience they cannot realize the indirect expense of depreciation, finance, overhead, etc.; as a result they assume a contentious attitude on all items of extras or force account. In like manner they permit impressions to prevail that contractors' profits are in excess of the true amounts. We know of instances where local business men were convinced from their contact with the engineers of the advantages of construction work, where as a matter of fact very little profit, if any, existed. The creation of these false impressions is particularly damaging to the industry. It is our aim to place in the hands of engineers when opportunity presents such information as was presented in our convention or published in our magazine.

Practically all engineers who come out of school and go to construction work have ambitions to be something other than inspectors or resident engineers all their lives. Many have the desire to become contractors or develop themselves to the point of stepping into either the machinery or material field. By nature of their training they are observant, and are especially interested in the details of construction costs and management. So far in our contacts we have found that these engineers take an active interest in the work we are endeavoring to do.

Finance Most Vital Problem.—The most vital problem of construction work at present is that of finances. This is especially so when the question of false credit is under consideration. It is our opinion that in the past the contractors themselves have abused their banking connections and kept the banker in doubt as to their financial standing. Neither have the contractors seen fit to keep their bankers advised as to the nature of the contracts on hand. The contractors' proper attitude toward his banker can be best explained by reciting the personal acts of one reliable contractor in our association. Prior to submitting his proposal on a prospective contract, this contractor prepared a detailed estimate of the cost of the improvement and placed it on the desk of his banker, explaining the condition fully. If he is awarded the contract he supplements the original information with an additional report every month or six weeks. During the construction season he makes it a point to take his banker on a trip of inspection permitting him to see for himself that conditions are exactly as set forth in the estimates. Upon the conclusion of the work a complete statement is submitted. By his action this contractor has secured the confidence of his banker. He reports further in fact that banking institutions so treated have repeatedly refused to do business with those who have not properly arranged a clear, concise financial program.

Contact with State Bankers Association.—Recently our association has developed a contact with the State Bankers Association in Illinois. We have found it possible to have the highway contracting industry discussed in the trade magazine of that association.

This discussion took the form of a series of questions and answers. The questions asked were those that must occur in a banker's mind when approached for financial help in paving contract work. The answers were given from the viewpoint of one familiar with construction practice. This naturally led up to the financial requirements such as are contained in the questionnaire prepared by the joint committee of representative American societies on construction practices. These forms, covering experience, plan and equipment, and financial statement, are used extensively by state highway departments, municipalities, consulting engineers and others. We were fortunate in securing the cooperation of the Illinois Bankers Association in placing 2,000 copies of this pamphlet in the hands of individual bankers throughout the state. To date much interest has been shown and requests for additional questionnaires arrive each week.

Relations of Association with State Highway Department.—The volume of highway department work attracts the attention of the most casual observer. The wide range of publicity given to highway programs naturally suggests the question: What is our association doing for contractors in their relations with the state highway department?

Formerly at a gathering of contractors the discussion soon drifted to the subject of complaint and criticism of the resident engineer or inspector. In the early years of state control many of the new designs and general advancement of construction practices were a source of annoyance to highway contractors. Also, few contractors had a good understanding of the quality of work demanded. In time the development of engineers and contractors permitted the establishment of recognized standards, but there still persisted a feeling that occasional inexperienced or arbitrary inspectors imposed unreasonable or uncalled-for requirements in the execution of the contracts. However, relief could be had by presenting the case to the district or main office, where every consideration was given. We believe the contractor always received his just due. But in many instances the engineer involved resented the complaint made to higher authorities, became vindictive and sought to square accounts, and most of the contractors believing discretion to be the better part of valor, accepted the situation or at least deferred from outward comment.

The Work of the Field Engineer.—In order to remedy this condition the association in the summer of 1926 placed an engineer in the field whose duty it was to assist in the adjustment of complaints, secure uniformity of inspection and in general to promote a better feeling of cooperation between engineers and contractors. Probably no organization can function exactly as planned . . . at least this one did not. Some of the activities were actually undertaken but soon developed different trends than anticipated.

The greater part of the construction season was spent in calling upon contractors. Work was visited in the field and each contractor given the opportunity to air his grievances. Information came slowly, as most men were reticent to go into details of their difficulties. Individual adjustments were inconsequential. In time we worked out a plan whereby all these differences of opinion were collected and treated collectively, definite corrections which emanated from either the main or district offices were secured. In this manner no offense was incurred and no ill feeling existed between the field representatives of either party. In other words, all action was indirect. The name of the contractor presenting the complaint was kept confidential and in some instances the main office of the highway department was never aware of the district in which the acts had been committed. It was necessary to exercise considerable care and not become involved in the personal whims of every individual. To have become a meddler in affairs would have gained nothing. We would have lost the respect of the highway department, without which our situation would have been helpless. We would not have you think we win all our contentions. We don't, but if in our judgment the case is meritorious we continue to knock at the door until we receive the attention to which we feel we are entitled.

We believe that officers of an association can spend time profitably in maintaining acquaintance with the district engineer or other responsible representatives. Visit their offices, or better yet, accompany them on the inspection of work in their territory. Some information may be gained concerning the engineer's viewpoint, and where the association representatives is possessed of sale ability much may be accomplished in shaping their ideas as regards construction work. The development of business relations with the heads of the field forces on construction is a most important duty for the representative of any association.

Revision of Specifications.—Specifications are always in process of change. To the correctness of this the many supplemental sheets and special provisions of proposals bear witness. Revisions of the Illinois state specifications have been pending for some months. Suggestions and criticisms were invited, collected, tabulated and forwarded to the highway department for consideration when the rough draft was prepared. It was gratifying to us to find that we were entrusted with the only preliminary copy of the revised specifications outside of the files of the department. A committee of our association was also invited to participate in a final hearing. There is no doubt that many benefits are derived from such contacts. The probability of arbitrary or unfair requirements is reduced, and we gain materially in understanding of policies and practices through the round table discussion.

Service in County Activities.—Our opportunities for service in county activities are with few exceptions unimportant. The limited county work is scattered and scarcely warrants our giving it much attention. In anticipation of the day when the gas tax fund will be available we are endeavoring to establish or rather renew our acquaintance with each county superintendent of highways. In the metropolitan areas near Chicago and St. Louis where large sums are now expended, special problems arise. Recently in one county estimates on pending work were arbitrarily reduced. Contractors were able to secure the appointment of association representatives on a committee for consideration of estimate revision. This committee comprised the county engineer, the assistant district engineer of the division of highways, an efficiency expert, an engineering representative of the city regional planning board, one contractor, the secretary of our association and our engineer. After weeks of work revised estimates were prepared on 13 sections of pavement involved and an acceptable majority re-

port presented. The increases ranged from 4 to 30 per cent, with an aggregate increase of more than $150,000. For once our association showed a tangible benefit.

Municipal work is much more difficult to serve. Practices and standards are varied. Cultivation of the acquaintance of city councils and city engineers is almost impossible. At present many municipal bodies are looking to the state highway department for advice and counsel in their paving problems. We believe our activities with the highway department will in a measure be reflected in the municipal standards developed.

So far the association activities as outlined have been confined to those inside the state. Experience gained in our contacts with construction operations for several seasons past indicated that there are influences at work outside the limits of our local territory which are deserving of attention.

The Outside Contractor.—The publicity of large construction programs attracted contractors from many states of the union. Apparently few of these outside men ever gave much time to a study of conditions. They jumped in blindly, unfamiliar with construction practices and submitted bids that frequently were below the prevailing price level to secure contracts. This condition was particularly discouraging to our Illinois contractors, who had assisted in the promotion. It was they who bore their portion of promotion expense, paid their taxes to political subdivisions of government and made their contributions to political activities. In comparison the outsider contributed little or nothing to the cause. Frequently today you can find them constructing pavements with trucks bearing the license of some other state and this revenue of license fee is the economic basis of all highway programs in our state. Again this outsider imports a considerable portion of his skilled labor, purchases his construction equipment elsewhere and carries away the profits, if any, to his home bank. Not very gratifying except we are convinced that not many took profits away, as very few were so successful as to be interested in repeat contracts. To us this seems a problem of economic waste to contractors, associated industries and the public as well. The savings that should have accrued to the public in the acceptance of low bids of this character are more than dissipated by the failure of such contractors to make their contributions to the economic life of the community.

To correct such conditions means expenditures of time and effort. Our president has labored for the development of strong contractors associations in other states. We hope that these associations, together with the national association, may in time develop a spirit of state rights. This subject of state rights is too long for discussion here but we believe if once developed it could do much to eliminate this evil.

Construction Equipment Depreciation.—The depreciation of equipment employed on highway and municipal work presents a problem in construction costs that has not been thoroughly understood by the contracting profession. The useful life of most construction equipment extends over a period of several years. Were its usefulness and utility consumed within the limit of the construction season an expense charge covering the entire first cost would be entered in the cost record and would be understood by all. Unfortunately the computing of depreciation or actual wear and tear on equipment is not so simple. In like manner there has been but little uniformity among contractors in the methods employed to meet the requirements of the income tax department of the Internal Revenue Bureau. Our association has exerted its best efforts in conjunction with the A. G. C. to develop a better understanding of depreciation, such as has been worked out by a joint committee acting with the engineers of the Internal Revenue Bureau. This development is highly important, as it concisely sets forth the approved methods that will be recognized in future computations of depreciation. Every contractor would do well to familiarize himself with the report of this joint committee.

At present the association has under consideration questions of false credits, unsound competition, bonding practices and that of state rights. As yet these subjects have not taken such definite form as to permit description in this article. The question of public relations has not been neglected. We are convinced that it is our duty to support the demands and requirements of public engineers for better engineering structures. We should only concern ourselves with a fair and uniform interpretation of specifications and practices. The more difficult a structure is to build the greater will be the premium placed upon your skill and ability as a contractor.

Highway Maintenance in New Mexico

An interesting statement regarding New Mexico's Maintainance program is given in a recent issue of Colorado Highways, by W. C. Davidson, State Highway Engineer.

Maintenance of the state highway system, consisting of 5,000 miles of road, will be concentrated under four main districts, the actual direction of operations being in charge of the district engineers. An approximate equal division of the state has been mads, so that each of the four districts has about 1,250 miles of road to be maintained.

In each district, there will be a district engineer and from one to two assistants. Maintenance operations will be directed by this personnel. In addition to the engineering force, there will be a corps of maintenance foremen who will be in direct charge of the patrol or maintenance crews.

Insofar as possible an effort will be made to standardize the types of equipment to be used on maintenance. The reason for this is to maintain uniform maintenance methods as well as uniform methods in the care and repair of equipment. The use of army type trucks will be discontinued as rapidly as possible and modern equipment substituted therefor.

The equipment for the average 40 to 60 mile patrol division would be about as follows: two 5-ton tractors, one heavy drag or maintainer, one 7 to 8-ft. grader equipped with extension blades, and a 1-ton truck. Supplementing this equipment, would be heavy maintenance equipment; this latter equipment to be used only occasionally.

The complement of heavy equipment would be as follows: one 10-ton tractor, one 12-ft. road grader equipped with scarifier attachment and back slope attachment. The use of such equipment would, of course not be restricted to a single patrol, but would be used over a large number of patrols, possibly covering two or three counties.

At each district headquarters there will be maintained a general repair shop. This shop will be equipped both as to men and machinery for the repair of any and all equipment of the district. The major overhauling jobs will be taken care of at these shops, as also the overhauling and assembling of various units such as motors, transmissions, and other minor units of a truck or tractor. A crew of men consisting of a shop foreman, four to five mechanics in the shop, and a general field mechanic will, as a rule, service all the equipment in any particular district.

The time of the field mechanic will be spent almost entirely in the field in the matter of minor repairs and adjustments to equipment, installation of motors, transmissions and other units which have previously been repaired in the shop, and other work of a minor nature not requiring the use of general shop equipment.

Closer Spacing of Pickets of Snow Fence Favored.—Experimental work of the Research Department of the Michigan State Highway Department indicates that the closer spacing of pickets of snow fence produces shorter drifts and thus permits placing the fence closer to the road. This is desirable because it avoids the action of diagonal winds on long drifts. Fence purchased for the present winter by the department was specified with 1½ in. spacing between pickets instead of the former standard of 2 in. spacing.

The Relation Between Contractor and Engineer

The Necessity and Advantages of Cooperation Between Engineer and Contractor

By E. ROY WELLS
of Wells Engineering Co.

IN the preparation of this paper, I have treated conclusions which have not only resulted from my contact with various contractors but also observations of other engineers, their experiences with contractors and knowledge of contractors' experiences with engineers and specifications.

Contractor and Engineer Defined.—The defintion of a contractor is: One who constructs for a stipulated sum. The definition of an engineer is: One who designs, inspects and has charge of construction and in times past it was nearly the universal custom to carry out these definitions literally. Years ago as soon as a contractor was awarded work he was a marked man in the eyes of the general public, one who must be watched on every move that was made on the construction for which he had contracted; and the engineer, as the representative of the city for whom the contractor was doing the work, was the particular individual who was delegated to do the watching. In the eyes of the public the engineer who would stand around and criticise the work, cause dissension among the workmen, disrupt the organization, hinder production and make himself prominent as an obstructionist, was the engineer who was fulfilling his duties properly. The sight of a contractor and an engineer walking down the street in friendly conversation would be just cause for criticism that the work was not being constructed in the proper manner and was not receiving the proper inspection.

Services of Engineer and Contractor Inseparable.—However, times have changed. Contractors of today are as a whole an intelligent, honest body of men and engineers have developed until their duties are broader and they are constructionists rather than obstructionists.

The engineer is the paid representative of the officials of the municipality who in turn are the representatives of the people paying for the improvements. It is the engineer's duty to plan and supervise the construction of the improvement in the best manner possible and as economically as posible. The contractor, too, is interested in constructing the work which has been awarded to him to the best of his ability and with a profit to himself, if possible.

There is a true saying that no improvement is better than the engineer's design. It is equally true that no improvement is better than the contractor who builds it and this brings me to the point which I wish to emphasize: That the service the contractor owes to the city and the service the engineer owes to the city are inseparable if the property owners who are paying for the improvement get the best improvement possible as economically as possible, and this can be obtained only by cooperation betwen the contractor and the engineer.

Cooperation Necessary.—Cooperation —the act of working jointly together— is paramount to gain the result for which the contractor and engineer are both paid.

Cooperation is imperative if the contractor is to get the greatest efficiency out of his organization.

Cooperation is necessary if the engineer is to realize his ambition of having the work under his supervision stand out as a monument to his efforts and careful design.

Cooperation cannot be had if the contractor considers the engineer primarily as a necessary evil on the job, theoretical, with no practical knowledge of construction, and no desire to have the contractor make a fair profit on his work; or if the engineer considers the contractor as a person trying to fulfill his contract as cheaply as possible, scrimping the work if possible, and with no interest in securing a better job than is absolutely necessary.

Contractors Want to Do Good Work.—In our work I have never come in contact with a contractor whom I have considered dishonest or who did not wish to do good work although I have come in contact with contractors who, through ignorance, and possibly laxness, were not capable of doing good work on their own initiative. It is often the case that an engineer will mistrust a contractor through the acts of the workmen. Invariably, any of the methods used by workmen to cheat the specifications are an insult to the intelligence of the engineer and are caught by him before the condition has existed for any great length of time, and before any appreciable damage has been done except possibly to raise an element of doubt in the mind of the engineer as to the sincerity of the contractor.

A contractor cannot be too careful in the selection of his foremen, nor too exacting in his instructions to them to guard against such conditions, as it is the foremen who have the direct contact with the laborers and as a rule the foreman who permits such things to happen, or the laborer who would do such things, is not an asset to any organization. Furthermore, any man on the construction of an improvement who will cheat, soon conceives the idea that he is smart because he has put something over on the engineer, and delights in telling the public at large. Immediately both the contractor and the engineer are accused of crookedness and incompetence, and an element of doubt arises as to the construction of the improvement as a whole which sometimes cannot be removed, no matter how well the improvement is constructed. Probably all of you contractors have experienced this misfortune and while it is no small task to perfect a good organization and involves a considerable amount of detail investigating, I consider that it is very important. If an engineer comes to you with a request that you discharge a man for incompetency or some other reason do not disregard his request with the idea that he is a crab; but investigate, and in nine times out of ten you will find that the engineer is right and that he is saving you money and trouble by the request. That is cooperation mutually beneficial.

The ignorant contractor, the contractor with insufficient, antiquated equipment, the contractor who does not care and has no pride in his work, is the greatest menace to the construction profession and I am pleased to see that they are getting fewer each year. While the diminishing ranks are partly due to the educational efforts of your organization, I believe a great deal of credit is due to the cooperation of the engineer who discourages them from bidding, refuses them plans and bidding blanks, or who recommends to the officials awarding the contract that their bids, if they do insist on bidding, be rejected if they are low (and they usually are low) in favor of the responsible bidder. In doing these things the engineer, of course, is protecting the interests of the people by whom he is employed, but he is also protecting your interests although he has invited the enmity of the contractors he has disciplined and has made "knockers" of them so far as he is concerned which may lose business for him on other

projects on which he is attempting to secure the services as the engineer.

The Fight Against Unjust Competition.—Since, in your fight against unjust competition from the ignorant and irresponsible contractor, you are receiving the aid of the better class of engineers who are educating this class of competitors or elminating them entirely from bidding, you contractors, too, have your duty toward engineers. We must confess that we, too, are confronted with competition from engineers who are incompetent, ignorant, careless and untrustworthy, and who are willing to work for almost any price as it is not their intention to deliver the proper engineering services. You men, in your work in municipalities and assocation with city officials where improvements are contemplated, are in a position to know the ability of different enengineers and are often asked as to their ability, or are asked to recommend an engineer. When given the opportunity you should emphasize the necessity of obtaining good engineering services and that in the selection of an engineer, ability should be considered far greater than cost. I think that I am safe in saying that you contractors, as a whole, have been too reluctant in giving opinions to officials of municipalities regarding the ability of various engneers and consequently you often have to contend with engineers who are irresponsible and incompetent. They should be considered by you in the same light as we consider the irresponsible contractor and you should do all in your power to have them eliminated as they are a hazard to you. You men can do more along this line than we engineers can for we are accused of "professional jealousy and unprofessional etiquette" as soon as we start to criticise.

The Matter of Overhead in the Bid.—Furthermore, there are today a great many, I might say, successful contractors who need a lot of education and because of the need of this education cooperation between the contractor and the engineer is lacking. Mainly, it is this:

An engineer, if he is what the name implies, must have a good knowledge of cost of doing work, cost of materials, etc., and with this knowledge he will estimate the cost of a project with a fair profit to the contractor, taking into account the necessary incidentals of overhead, insurance, bond discount, depreciation, etc. Bids will be received and you men will come in and forget that you ever had to purchase equipment, ever had to repair the equipment, or ever had to replace the equipment—you forget that there is such a thing as insurance, or bond discount, or overhead, or lost time, and because you are afraid someone else might do the same thing you bid the job off at labor and material costs plus possibly a small profit, and pray for a break in your favor if you are successful and awarded the work. The engineer stands before his board with possibly a 20 or 25 per cent cut in his estimate. He is asked the reason for his high estimate, and his only explanation is that contractors are greatly in need of work or that they have gone crazy. However, the board and the public at large think it is the engineer who is either crazy or grossly incompetent. Finally, after a few such occurrences, in spite of his better judgment, the engineer reduces his estimates to where the contractors have been bidding—forced to do so by their own acts. Then you contractors criticise the engineer because the estimates are so low that it is impossible to make any money. On an improvement which has been taken at a very low price it is really hard to get proper cooperation. The engineer still expects and is determined to get the class of work he has specified, and it is difficult to get it from a contractor who has thrown away his profit. You all seem to realize this as soon as the letting is over and construction has started; yet some of you will do the same thing on the next improvement, and I presume that in your desire to get work this condition will always exist from time to time.

The Problem of Specifications.—When you are awarded a paving job you are required to sign a contract in which there is a provision that the plans and specifications are a part of that contract. In return for a certain consideration you are going to be expected to do certain specific things, accomplish certain specific results in certain specific ways. If all contractors were intelligent, trustworthy, competent, properly equipped and properly financed, the problem of specifications would be a simple one; but as this is not the case the specifications governing an improvement must be complete enough to cover all contingencies and at times to you men they must seem absurd and severe. Normally, if there is cooperation between the contractor and the engineer they are both working for the same result and the specifications are used only as a guide to get that result. However, I cannot emphasize too strongly the fact that you men should carefully read the specifications before bidding on an improvement as some method of construction may be specified which possibly is no better than your own but which you will have to use, greatly increasing your normal labor costs or necessitating the purchase of additional equipment at a substantial financial outlay. I believe that engineers should keep their methods as near standard as possible so as not to work a hardship on a contractor by specifying pet methods. These methods invariably increase the cost of the improvement without materially bettering the improvement when completed.

Methods of Construction.—In preparing our specifications we make the result that we desire paramount, permitting the contractor to use his methods of construction if we consider them satisfactory. However, we have our own standard methods and if after a fair trial we are convinced that the methods used by the contractor are not satisfactory we then insist on the change from his methods to our own, showing him how better results may be obtained by the changes, in addition usually to greater production and cheaper costs. In other words, our years of experience have taught us to minimize the theoretical side of engineering for the practical side as much as can consistently be done and keep within the limits of good engineering practice.

The Political Inspector.—An evil that confronts both the contractor and the engineer on construction work and one which both should strive to eliminate is the political appointee as an inspector. He usually is a friend of one of the city officials or a factor in the political organization, and a man who has absolutely no experience on construction work or engineering ability. He is either careless, with no interest in the work other than drawing his salary, or feels his importance and exercises his authority injudiciously. He creates a state of carelessness and dissatisfaction among the workmen; he is no aid to the city, the contractor or the engineer—in fact, he is a menace and jeopardizes the whole project. Cooperation on the part of the contractor and engineer, diplomatically used to educate the city officials, can often remove this class of inspectors and it is to their mutual interest to do so.

Laying Out Work in Advance of Construction.—On construction work, you contractors often lose a great deal of money on lost production occasioned by changes in grades and the fact that the work is not laid out for you far enough in advance of your construction so that your organization can function properly and I have this suggestion to make to you: Before you are ready to start construction, if the improvement has not been staked, call on the engineer and diplomatically urge that this be done. Offer the services of some of your labor if necessary, in order that the greater portion of the improvement, if not all of it, be staked before you start work. Next, it is equally important to have all necessary levels run on the work that has been staked. If you accomplish this you will have very little reason to charge anything to loss in production as the engineer is then in a position to permit you to carry on any portion of the work that you desire in any portion of the improvement, and he also will have time to review his preliminary grades and make any changes he desires far in advance of your work. Most of the changes in grades that are made between the time of grading and the construction of the curb and gutter or pavement, which are so costly to the contractor, are due to the fact that the

work has been staked hurriedly just in advance of the grading operation and then possibly only a block at a time. For this reason the engineer has not had time to study his grades carefully and any changes from his preliminary grades that are necessary are not discovered until later, much to the sorrow of the contractor who is required to fill in a foot or grade out an extra two inches after the subgrade has been all prepared and rolled. It is true, he may be paid for this extra work but there will be no extra coming to him for the loss in time and production for the curb and gutter crew or the paving crew that is waiting to get on that section. It takes an engineer no longer to stake an improvement at one time than it does another, and the proper time is in advance of any construction work. This is our rule and one that we follow without deviation. It is a rule that you contractors for your own protection must educate all engineers to follow.

In closing, I wish again to state that if the tax-payer is to receive the improvement to which he is entitled and is paying for, if the contractor is to do the work he has contracted for as economically and as efficiently as possible, and if the engineer is to obtain the construction that he has specified and shown on his plans, there must be cooperation between the contractor and engineer.

Acknowledgment.—The foregoing paper was presented by Mr. Wells at the 21st Annual Convention of the Illinois Association of Highway and Municipal Contractors.

Urban County Highway Maintenance

Committee Report Presented at Convention American Road Builders Association

By W. W. CHADSEY, Chairman
County Superintendent of Highways, Schenectady County, New York

URBAN COUNTY HIGHWAY MAINTENANCE is the title of this paper that has been prepared by me from reports furnished by members of this Committee. From the reports I find that laws of states, rules of boards of supervisors, or highway committees of these boards, and officers in charge of maintenance work vary greatly, and in some counties are a hinderance to good practice. Therefore it is the intention of this committee to recommend in this paper what we consider a good practical method of maintaining urban highways. As it is not our intention to assure you that this report is the most proper method to follow, as we are not familiar with the conditions existing in each county of these states, we expect you in several cases to differ with us. An article in the November issue of "Roads and Streets" reminds us of the miserable condition of some of our unpaved roads, which would be good reading for most county officials.

Uniform Practice Needed.—It is a fact that there must come a uniform method of doing county road work in all states, if we are going to get the most for our money, and to that end I would like to read parts from the reports I have received from three states as to the methods followed, to show the variance in the methods followed. The first county reports as follows: We have no uniform method of doing county road work; in fact it is done in the most unbusiness like way imaginable. The counties are subdivided into magisterial districts and a supervisor elected from each district who represents his district on the board of supervisors and he usually buys equipment and employ a foreman to look after the work in his district. The result of this system has been a large waste of funds through a duplication of machinery and by having inexperienced road men elected. A further complication of this system has resulted by the fact that over 80 per cent of the counties in this state have had special road laws enacted.

County Unit Favored.—In my own state the County Superintendents Association is trying to correct all of the evils that evist because we are operating on many systems, some on the county unit and some on the town unit, and from reports received by me I am very much in favor of the county unit which I will explain later.

From another state in the west the county superintendent reports that the several methods exist, but that all hard surfaced roads constructed by the counties are maintained by the state, which allows the several counties to carry on a most satisfactory system of maintenance.

In my county we are working under the county and town unit at present because of the fact that I have only been in this position for two years, and am gradually changing to the county unit, because some of the roads under construction when I took office will not be completed until this year, when we will work on the one unit.

Objection to Town Unit.—The most trouble I find with the town or town and county unit, and as I have found from the reports from the several states, is that when the town superintendent of highways or someone with a like title is working under the county superintendent, trying to construct permanent roads and at the same time most generally with the same men trying to maintain dirt or urban roads, that one or the other types of work is neglected. I know that it is so in my county. Therefore it is the recommendation of this committee that we who are in charge of highways within our counties try and find methods that will be most advantageous to our counties for the construction and maintenance of the highways, by considering the following recommendations and improving on them to the end that every dollar spent on a dirt road will be so much expended toward the construction of a permanent road. Study the road as to its topography, the number of people living alongside and along roads connecting, its relation to improved state or county roads or roads to be improved, the ways and means to carry surface waters from the road, the grades as the surface now exists and how they can be changed at this time so that they will fit future construction, without becoming expensive during the maintenance period, but when the time comes for permanent construction the earth foundation will be ready for the top courses, and be sure that the ditches are wide and deep enough to carry all of the water that will reach them from the road surface and from the lands alongside.

Now to maintain these roads in these days it is not for us to tell you what machinery you should use, as it is on display within our vision in this building, but if some of your supervisors are still of the opinion that manpower is the only power to use for this work, study the machinery here and advise.

The Patrol System.—Organize a patrol system for the maintenance work that may be large early in the spring, reducing to a small patrol after the spring work is completed to follow up the early work and lessen this work the following year. It has been found that once the roads are in good condition the total mileage can be divided into sections of approximately 15 miles in length and two men equipped with small tools and horse drawn light patrol graders can keep the road surface, ditches and culverts in a first-class condition.

It is a fact that there will be times during the rainy seasons that the roads will be washed to such an extent that the patrol will have to be increased for a short time, and that is the time to enlarge it, because if you wait for the regular patrol to care for such conditions, you may find that you waited too long and find the work costly.

Where there is found a great amount of grading to be done, it will be necessary to provide larger and heavier machinery. It has also been found that if a good supply of gravel is near, better results have been obtained by making all fills of this than by excavating earth and filling with it.

Oiling Dirt Roads.—It has been determined by experience that one of the best ways to maintain a dirt road is to oil treat them. In my county we oil treat a great many dirt roads and all of our cinder and gravel roads, as in the summer months the oil does away with the dust nuisance which in a dry season is very bad and in the rainy months and winter, the oil coating acts

as a roof for a well graded road, and the surface can be maintained for a considerable longer period due to the oil treatment than otherwise. It has been determined that oiled roads will pit up to a considerable extent if not properly maintained. Where pits have been allowed to exist the riding qualities of dirt surfaced roads are very bad, but experience has taught us that pitting can be taken care of by the maintenance man in charge of the road by the use of a small quantity of road oil, either mixed with dirt before it is tamped into the hole or by first cleaning out a hole, then applying a small quantity to bottom and sides and then filling up with roadside dirt, and then applying a small quantity of oil on top of it followed by a sprinkling of dust which keeps the oil from adhering to vehicles traveling the highways. About ½ gal. per square yard of road surface is used in two applications of a quart per application. The application of this oil depends to a great extent on the condition of the road when the oil is applied. If there is a fairly well oiled surface remaining from preceding years, the 1 qt. applied per square yard will be sufficient for the entire summer and then another application of a quart is made in early fall or late summer which will put the road through the winter in excellent condition if weather conditions are not too severe. We must not lose sight of the fact that snow left on roads all winter is the greatest enemy our roads has to face, and where some of the states or counties are removing snow from the hard surfaced roads a great many are allowing it to remain until the warm rains in the spring remove it.

Progress in Forest Road and Trail Construction

By G. H. LAUTZ
Assistant Chief Engineer
U. S. Forest Service, Washington, D. C.

During the past fiscal year there has been constructed a total of 1,370 miles of roads consisting of 292 miles of major highways and 1,078 miles of minor roadways. The road projects classified as major are those constructed by the Bureau of Public Roads while those built by the Forest Service are called minor. The former are state highways and other roads where construction work is difficult; the latter are county, community, and development roads of simple construction. The amount expended upon all construction was $7,713,535. Of this, $6,787,656 was secured from Federal funds and the remainder $925,879 from local cooperative, State, and County funds. The average cost per mile of the roads thus constructed was $5,632 per mile, the major averaging $19,599 and the minor $1,856. During the same fiscal year 1927, there was expended $946,622 for the construction of 4,987 miles of trials, which averaged $190 per mile.

In addition to the construction work, roads and trails were maintained requiring an expenditure of $1,593,950 during the fiscal year. $1,182,961 was used for the maintenance of 14,594 miles of roads and $410,989 was used for the maintenance of 50,667 miles of trails.

To July 1, 1927, there had been completed a total of 13,219 miles of roads at a cost of $62,044,158. This represents an expenditure of $47,775,034. Federal funds and $14,269,124 cooperative funds. The trails constructed to July 1, 1927, amounted to 31,607 miles. The money for this work was composed of $6,060,964 Federal funds and $251,012 cooperative funds, totaling $6,311,976.

The total amount expended for all road and trail purposes, that is, construction, reconstruction, maintenance, surveys, administration, and equipment has to July 1, 1927, amounted to $79,601,464. Of this the Federal Government contributed $63,989,508 and the local cooperators $15,611,956.

The desired transportation system for the National Forests as planned for the next ten years includes a total of 51,268 miles of roads and 110,385 miles of trails, 83 per cent of the former and 98 per cent of the latter being located within the forest boundaries. The road system is composed of 15,068 miles of forest highways and 36,200 miles of forest development roads. Forest highways are roads of primary importance to the states, counties and communities while forest development roads are those of primary importance for the protection, administration and utilization of the forests. Of the former, 75 per cent of the mileage is located within the forest boundaries; 5,084 miles of the forest highways are now in satisfactory condition, 8,687 miles are passable but unsatisfactory, that is, require additional expenditure of funds, and 1,297 miles are non-existing, that is simply planned for future construction in locations where no roads are located at the present time.

In the Forest Development System, 10,910 miles are considered satisfactory, 14,767 miles unsatisfactory, and 10,523 miles are non-existing. Eighty-seven per cent of the total mileage, 36,200 is within the boundaries of the Forests.

The roads of satisfactory standard included in the present system provide an average of 1.7 miles for each township within the National Forests and the unsatisfactory roads 2.3 miles per township. The proposed system will furnish to each township within the Forests an average of 5.4 miles of roadway. At the present time, of the 6,628 townships contained in the National Forests located in the western States, 33 per cent of the entire area are wholly without roads. That is, 2,188 townships or 50,411,520 acres do not contain roads of any kind.

The Forest Trail system is at present composed of 73,431 miles of trails constructed to a satisfactory standard, 12,461 miles of unsatisfactory trails, and 24,493 miles of proposed. From the above it will be seen that the construction of a large mileage of both roads and trails must be completed before the desired and necessary transportation systems have been accomplished. During the past year there was available for road and trail work $4,500,000 Forest Highway, $3,000,000 Forest Road Development and approximately $500,000 ten per cent money. The first was used for Forest Highways while the other two upon development roads and trails.

10,412-Ft. Timber Highway Trestle Placed in Service

The new highway bridge over Bay St. Louis, Miss., which was opened to traffic last month, is the longest bridge in the state. It is of timber construction and cost $850,000.

The structure was erected with funds contributed jointly by the adjoining counties, the State Highway Department and Federal aid. It serves to connect the town of Bay St. Louis with Henderson Point and is an important link in a transcontinental highway, the Old Spanish Trail. The bridge displaces a ferry that has operated in the past.

The roadway is 20 ft. between wheelguards, with a 4-ft. 6-in. sidewalk. The bridge is of creosoted timber and pile trestle with one steel swing span for the passage of boats. The trestle is composed of 21-ft. spans, using 8x14 in. stringers, 4x10 in. shiplap flooring, bents having six piles each. The piles varied in length from 50 ft. to 85 ft.

Yellow pine lumber and piles were used, being pressure treated with creosote coal tar solution, 16 lb. per cubic foot of lumber and 22 lb. per cubic foot of piling, except floor plank which received 8 lb. per cubic foot. All hardware is ingot iron galvanized, except structural shapes which were painted.

All creosoted materials were shipped by barge from Slidell, La., to the Bay. Approximately 3,000,000 ft. B. M. of creosoted lumber and 172,000 lin. ft. of piling were used in the bridge. All lumber was dressed.

For protection of the cresoted piles against marine borers, piles were encased from the bottom of the bay to the height of 3 ft. above mean tide. Vitrified clay pipe was used for encasement, the open space between being filled with cement mortar.

The roadway on the bridge was paved with a bituminous slag mat. The construction of the bridge was under the supervision of the Mississippi State Highway Department and was designed by the department.

Resurfacing Old Roads With Rock Asphalt On Bituminous Top

An Account of Four Projects Carried Out Last Year in Indiana

By A. H. HINKLE
Superintendent of Maintenance, Indiana State Highway Commission

THIS past year we resurfaced four different roads with the above type of top. One of such roads was an old concrete road which had been built some years ago but due to defective concrete and insufficient thickness of slab, had broken up badly under traffic, such that it was very expensive to maintain. Before resurfacing, the places that were too defective in the old concrete slab were patched with concrete. The old concrete was given a light surface treatment of liquid asphalt CB or asphalt OH2 and No. 4 covering to roughen the surface and thus avoid a slick, hard condition which would permit the macadam stone to slide about under the roller. In the other three projects this top was placed upon old macadam roads after they had been leveled and trued up with a water-bound macadam course.

Spreading Coarse Aggregate on Old Concrete After It Had Been Surface Treated with Liquid Asphalt and Berm Stone and Side Forms Had Been Placed

Constructing Bituminous Macadam for Rock Asphalt Top.—On the old road prepared as described above, a bituminous macadam layer about 3½ in. thick was constructed. This bituminous macadam was constructed according to our standard specifications, except that only about 1.25 gal. of tar or asphalt per square yard were used in two applications instead of about 1.8 gal. as are used in the standard bituminous macadam. Also, only about 10 lb. of covering stone were used per square yard. This limited quantity of bituminous material and covering stone left the surface of the black base with voids so that the rock asphalt well anchored itself to the penetration macadam.

Three-Fourths In. Rock Asphalt Top.—Upon this black base a rock asphalt top was built with a compacted thickness of about ¾ in. deep.

The amount of rock asphalt used was 75 to 80 lb. per square yard.

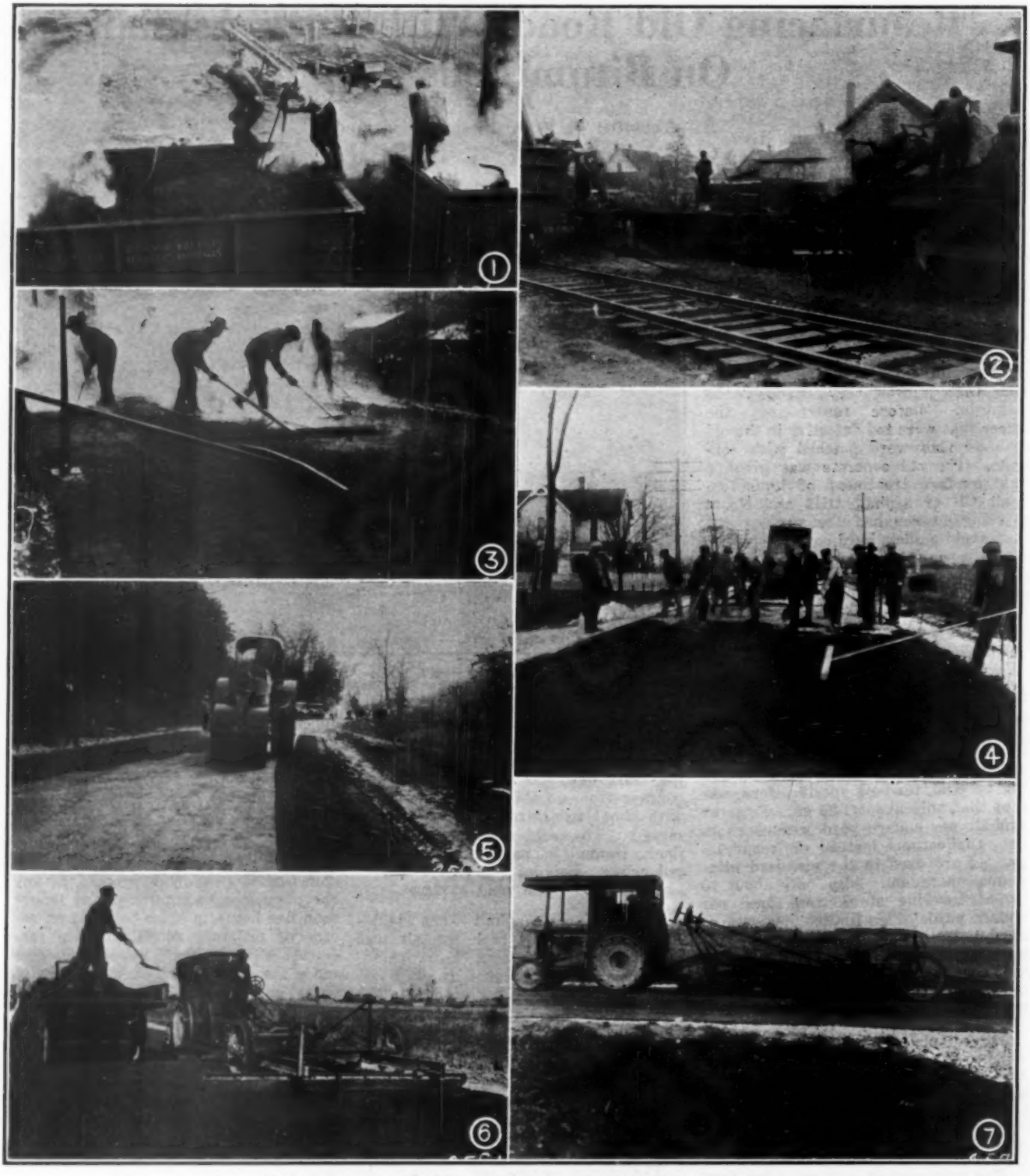
The rock asphalt was unloaded from cars by hand shovels or with a small ½-yd. gasoline shovel. As the cold weather approached, making it difficult to handle, the rock asphalt was either pulverized without heating or it was heated with steam in the cars before removing it.

Cold Pulverized Rock Asphalt.—The rock asphalt that was pulverized was passed through a pulverizer stationed either on the road surface just ahead of the spreading or at the side of the car where the shovel dumped the cold, lumpy rock asphalt directly into the pulverizer. The pulverizer used on the work consisted of a cylinder and concave from an old threshing machine with about two-thirds of the teeth removed. The cold rock asphalt was finely ground in passing through the pulverizer. This made it easy to shovel and spread on the road surface.

Steamed Rock Asphalt.—The steaming process of the rock asphalt was accomplished by forcing ½-in. perforated iron pipes about 4 ft. long attached to a ¾-in. steam hose, into the rock asphalt at various places in the car. The pipes were forced through the rock asphalt to the car floor and then raised a few inches which permits the condensed steam to drain off through the floor and thus reduce to some extent the moisture collected in the rock asphalt.

The steam passes out through the perforations and bottom of the pipe and rises up through the surounding rock asphalt and heats it to the desired temperature. As the shovelers approach the pipes, the pipes are reinserted in the rock asphalt ahead. Care should be taken to insert one pipe near enough to each corner of the car so as to heat the rock asphalt clear to the corner. Sufficient pipes to keep a uniform temperature of asphalt ahead of the shovelers is very desirable for an uneven heating is liable to add to the difficulty of spreading the rock asphalt to a uniform surface on the road, since the hotter rock asphalt will compact more readily than that with the cooler temperature.

It usually takes about 2½ hours for the steam to sufficiently heat the surrounding rock asphalt and it is desirable that the steaming process, at any one place, not be continued any longer than five hours in order to avoid an excess of moisture resulting from condensed steam. The steaming process made the rock asphalt soft and easy to shovel and spread; however, due to its soggy condition as compared with the dry pulverized material, it is more important to be on guard against a non-uniform density of rock asphalt when it is spread on the surface. For instance, if a workman throws a big shovel full of steamed material with some force on the road scurface, it is liable to produce a more dense mix at this point which will eventually result in a slight elevation on the finished rock asphalt surface. The cold pulverized rock asphalt being dry presented less difficulty from this source. Hence, we conclude that it was a little easier to secure a smooth surface on the road with the cold pulverized rock asphalt than with the steam heated material; however, there seemed to be no objection to the moisture from the steamed product even when laid at temperatures near or below freezing. Comparing the results secured with the two conditions,



Various Stages in the Construction of the ¾ in. Rock Asphalt Top

(1) Steam Heating Rock Asphalt in Cars. (2) Unloading Rock Asphalt from Cars, Grinding and Loading It into Trucks. (3) Raking and Luting Steam Heated Rock Asphalt. (4) Cross-Luting After Metal Strips Are Placed. (5) First Rolling of Steam Heated Rock Asphalt (Rollerman Should Have Started at Shoulder and Worked Towards Center. (6) Feeding Pulverized Rock Asphalt in Front of Planer as Part of Smoothing Process. (7) Planing Cold Ground Rock Asphalt After First Rolling.

it is quite evident that the steam heated material showed no signs whatever of raveling when laid as late as Dec. 1st during freezing temperatures while the unheated product does show some symptoms of raveling when laid at this low temperature.

Spreading Rock Asphalt on the Black Base.—The pulverized or heated rock asphalt as described above is dumped by trucks just ahead of the shoveler on the road and shoveled in place. Metal strips ¼ in. thick, 1⅛ in. wide and about 18 ft. long, bent at right angles near one end to prevent them from tipping over, were laid 3 ft. apart on the road surface to be used as a guide in gauging the thickness of loose material. Rock asphalt was then raked to as near the proper elevation of the metal strips as possible and afterwards brought to the exact level of the metal strips with a 3½ in. triangular lute 4 ft. long having a handle

12 ft. long. On some of the work 7 ft. lutes were used. This longer lute rested on three of the metal strips as it was pulled forward. With these lutes, the loose rock asphalt was brought to a very uniform surface. As the metal strips were slid forward, the loose rock asphalt behind was leveled by cross-luting with an oak lute 1 in. thick and 6 ft. long having a handle 12 ft. long. By this cross-luting the marks left by the metal strips were removed.

Rolling and Planing.—The rock asphalt was first rolled with either a 5-ton tandem or a 10-ton 3-wheel roller. After rolling but once the rock asphalt was planed to a level surface with a long base metal planer which cut the high places and filled the low places with loose material. On part of the work planing was done on the loose rock asphalt before the first rolling. There were indications that with the thin layer of rock asphalt used that this might even be a more practical process than rolling before planing. The planing of the loose material in this manner leveled the rock asphalt in about the same manner as the planer levels the loose gravel in dragging a gravel road.

Additional rock asphalt was fed in front of the planer blades where necessary so as to keep at all times some loose material that would fill up any small depressions in the surface. After going over several times with the planer, the surface was again rolled and where necessary further planing done. In all cases, the final rolling was done with a 10-ton 3-wheel roller. We were not able to conclude from our experience as to how much merit there may be in using a light roller for the first rolling.

Curing Before Planing.—It is found that the time for curing before the first planing was a variable quantity ranging all the way from a half day to a week depending largely upon the atmospheric temperatures. The rock asphalt which is laid in October normally had to cure four or five days before it could be successfully planed. During the late November and early December weather when we were using steam heated rock asphalt, the material was rolled as soon as possible after laying, and planing was done 6 to 24 hours thereafter.

Experience will soon teach one that there is only a certain stage in the curing process during which the planing can be successfully done. If an attempt is made to plane the surface too early, the planer blades will tear up large areas of the surface whereas if the time is delayed too long, the rock asphalt will become so hard that it is very difficult to plane off the high places.

One stretch of pavement that was laid and permitted to harden too long in a rough condition was smoothed up with difficulty by scraping with a heavy 12-ft. blade grader. If the planing is delayed too long, the loose material scraped off the high places will not readily bond to the surface on the depressed areas.

The above methods and processes of laying the rock asphalt surface make a much smoother riding surface than ordinarily is secured by the usual methods that have been used consisting in merely raking and rolling. Experience demonstrated with the above processes it was not difficult to secure a surface which showed no depressions greater than ¼ in. with a 20 ft. straight edge nor greater than ⅛ in. with a 4 ft. straight edge when laid parallel with the center line of pavement.

All indications from our experience for two seasons are that the bituminous macadam is a very satisfactory course on which to lay a thin rock asphalt top.

Acknowledgment.—The foregoing is taken from a paper presented by Mr. Hinkle at the 14th Annual Purdue Road School.

Penetration Macadam Ready for Rock Asphalt Top

Committee of Engineers to Report on Highways

A committee of leading highway engineers has accepted an appointment to make a thorough and impartial study of all types of road and street pavements and to embody the same in a report which is to be made public when completed.

The committee is composed of Wm. H. Connell, chairman; Warren R. Neel, Perry J. Freeman, Frederick J. Cellarius.

Wm. H. Connell, chairman of the committee, is past president, American Road Builders Association, and was engineering and chief executive of the Pennsylvania State Highway Department 1923-27. Other highway activities of Mr. Connell have included head of highway work in the Borough of the Bronx, New York City, during which time he built the White Plains Experimental Roadway and installed the modern highway methods to cope with the automobile traffic. Since June, 1927, Mr. Connell has been engaged in general engineering and consulting practice in Philadelphia.

Warren R. Neel is state highway engineer of Georgia and in his present capacity has had supervision of approximately $60,000,000 road and bridge work. Perry J. Freeman is widely known as a highway testing engineer. Mr. Freeman organized the State Highway Testing Laboratory of Kansas. From 1916 to 1924 he was Engineer of Tests of the Pittsburgh Testing Laboratory during which time he was in charge of the testing of materials in about twenty-five laboratories in various parts of the United States.

Frederick J. Cellarius is a consulting engineer of Dayton, O., and formerly engineer for that city. Since 1914 he has been engaged in general engineering work, as consulting engineer in highway and municipal work. He has built a considerable mileage of pavements and highway bridges as City Engineer.

The committee was appointed by the National Paving Brick Manufacturers' Association at its annual meeting held January 25-26 in Chicago. F. L. Manning, the Association President, said the committee has been authorized to proceed with such surveys, tests and investigations on highway construction as would result in developing and codifying existing knowledge and be of benefit to the road users and road builders.

Scientific Planning of State and County Highway Improvements

A Paper Presented at the 14th Annual Purdue Road School

By J. GORDON McKAY

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THE past 20 years have seen the re-emergence of highway transportation from a position of comparative unimportance to a place of first rank in our national scheme of transportation. The registration of approximately 23,500,000 motor vehicles in 1927 compared with approximately 5,000,000 in 1917 is a remarkable illustration of the rapid growth in motor vehicle ownership and the need for improved systems of roads to furnish economical highway transportation of people and goods.

Traffic on Ohio Roads.—In Ohio, the state highway system, 13.0 per cent of the total rural mileage, provided highway service for a traffic of 2,160,435,000 vehicle miles, equal to 57.7 per cent of the total traffic on rural roads in the state in 1925; the county highways, which include 27.1 per cent of the rural mileage, provided service for 1,108,870,000 vehicle miles, 29.6 per cent of the total traffic; and the township highways, which constitute 59.9 per cent of rural mileage, provided only 12.7 per cent of total rural traffic. The daily traffic on the state system in Ohio averages over nine times that upon the county and township roads. The same relationship exists in Pennsylvania, and other states where traffic and highway planning surveys have been conducted.

Of the 11,000 miles of Ohio state highways 1.2 per cent carried 2,500 or more motor vehicles per day, 7.8 per cent carried 1,500 or more; 29.4 per cent carried 600 or more and 70.6 per cent carried less than 600 vehicles per day in 1925. Based on the forecast of traffic for 1935, approximately half the system will cary 600 or more vehicles per day.

In Ohio during 1925, the average daily density per mile on the state system was 538 vehicles, 132 on county highways and 26 on township roads.

Motor truck traffic is an important part of total traffic on state highway systems. In Ohio in 1925, 13.1 per cent, 1,442 miles of state roads carried 100 or more trucks per day and 27.5 per cent, 3,019 miles, carried 60 or more per day. Based on the forecast of truck traffic it is expected that by 1935 over 1,300 miles of Ohio state highways will carry 200 or more trucks per day.

It is clearly shown that the principal routes of a state system, comprising what are known as the Federal aid and main market or primary systems, are, with few exceptions, the most important traffic routes of a state. These facts show the necessity of allotting a sufficient portion of total highway revenues to complete first the improvement of the primary highway of a state.

Truck Traffic on State Highways.—Large capacity motor trucks and heavy loads comprise a comparatively small part of total truck traffic on the state highways of all the states. In Ohio nine-tenths of the trucks operating on the state system are small units, 2½ tons capacity or less. The 20,000 lb. gross load limit in Ohio is partly responsible for this situation. In Pennsylvania, however, during 1924 only 90 miles, 2.3 per cent of the primary highway system, carried 20 or more loaded 5-7½ ton trucks per day and this mileage is in the immediate vicinity of Philadelphia, and Pittsburgh. Only 358 miles, less than 10 per cent of the primary mileage, carried 10 or more loaded 5-7½-ton trucks per day. This mileage is adjacent to the important industrial cities of the state.

Federal Aid System Carries Bulk of Traffic.—The Federal aid system of the several states carries the largest part of the total traffic using the state highway systems. In Ohio, in 1925, the Federal aid system, slightly more than half the state mileage, carried 70.6 per cent of the daily traffic on the state system; in New Hampshire in 1926 the Federal aid system, 68 per cent of the trunk-line mileage, carried 80.8 per cent of the total trunk-line traffic; and in Vermont, during 1926, the Federal aid system carried approximately half the traffic on all rural roads.

Foreign Traffic Small Part of Total.—Foreign traffic comprises but a small part of total traffic, except on a few main through traffic routes. In Ohio, during 1925, 10.2 per cent of the daily passenger car miles on state routes were produced by foreign traffic, although on one of the principal interstate routes, U. S. 40, 23.6 per cent of the passenger car traffic was of foreign registration. Approximately the same proportions are true for states similar in traffic to Ohio. In states like Vermont and New Hampshire a large part of the traffic on state highways is of foreign registration. In Vermont 35.6 per cent and in New Hampshire approximately half the traffic was of foreign registration.

In states where a considerable part of the traffic is of foreign registration, the cost of constructing and maintaining the highways is materially increased by this class of traffic, and it should, therefore, produce at least a part of this additional cost of highway improvement.

City Owned Cars Principal User of Highways.—The several surveys completed by the Bureau of Public Roads clearly show that the traffic using our state highway systems is predominantly city owned passenger car and motor truck traffic, farm owned motor vehicles comprising only a small part of total traffic. In Ohio, in 1925, farm owned passenger cars and motor trucks made up only 12.4 and 15.5 per cent, respectively, of the total traffic.

In Vermont, during 1926, farm owned passenger cars comprised one-tenth and city owned passenger cars nine-tenths of the total passenger car traffic on the state aid system.

Motor Vehicle Ownership Factor in Highway Planning.—The distribution of population, and consequently of motor vehicle ownership, is an important factor in planning highway improvements. The volume of traffic in any given area is principally produced by the population residing within a radius of thirty miles, since less than 30 per cent of the truck traffic and 40 per cent of the passenger car traffic travels more than thirty miles per trip. In Ohio, for example, 80 per cent of the area of the state has a population of less than 80 persons per square mile and less than approximately 18 motor vehicles per square mile, while 9.4 per cent of the area of the state has a population of 160 or more persons per square mile and this area includes approximately 70.0 per cent of the state's population and motor vehicles.

These variations in Ohio, and similarly in other states, indicate marked differences in the requirements for highway improvements in the several areas of a state. In the densely populated areas the highway system should be planned to serve large volumes of traffic between the principal centers of population, with tributary feeder routes connecting minor population centers with the primary traffic routes. These routes should be of sufficient width and improved with surfaces adequate to carry the large daily volume of traffic, as directly as possible; obstructions to the free movement of traffic, such as railway crossings at grade, sharp curves, heavy grades and congested traffic sections should be eliminated, and by-pass

routes should be constructed to avoid the congestion which occurs when a main route passes through the business center of small villages and cities.

In the sparsely settled areas of a state the volume of traffic is smaller and its sources more scattered. A connected system of main routes comprised of small mileage, improved with gravel or the lower types of paved surfaces where traffic warrants such improvements, should satisfactorily meet traffic requirements in these areas, except on the main through routes traversing them. The removal of obstacles to the easy movement of traffic is not an important problem in areas of low population and traffic, particularly when the expectancy of future traffic increase is small.

Three Stages of Administrative Standpoint.—The development of highways in the United States from an administrative standpoint can be grouped in three stages. First, the early period of local control, with its inevitable evils of waste, inefficiency and the failure to develop connected systems of improved highways. Second, the period of state control, characterized by efficient engineernig standards and methods of improvement and resulting in the emergence of connected systems of improved state and national highways over which move an enormous daily volume of people and commodities. I believe we have already entered the third stage in the development of our highway systems where, I believe, lie the most difficult problems that will require solution in the near future and that is the scientific planning and improvement of state and county highways in the areas about congested centers of population and traffic.

Planning for Areas Near Cities.—The territory surrounding cities like New York, Chicago, Philadelphia, Cleveland, Cincinnati and Indianapolis present complicated problems of highway location and improvement; width; grade separations, both rail and highway; double deck roadways; parking areas; reservation of adequate right-of-way for future highway use; structures of traffic control problems that challenge the modern highway engineer. I wonder if we are adequately preparing for the future in areas of this kind. Adequate highway development in such areas demands cooperative planning by state highway engineers, county highway engineers and frequently by municipal highway administrators.

I believe that a careful analysis of traffic demands and a scientific plan of improvement for the highway system is imperative for state highway systems, and for the combined state and county highway systems in the areas surrounding congested centers of population and traffic. Such plans should be prepared for at least five to ten years in the future and the establishment of a yearly budget of expenditures based on required improvements should be an integral part of this plan. The preparation of such plans is the function of the state highway engineers for the state highway system and the cooperative function of the state and county highway administrators in metropolitan areas.

There is no fundamental difference in principle between the public business of developing systems of highways, and private enterprises engaged in producing commodities. For example, light and power, gas and telephone utilities and other industries are all engaged in the production of commodities or services for public use. The history of their modern development is based upon a careful analysis of the demand for their product by present and expected future consumers in any given area.

The same basic economic and engineering principles of management that exert such a controlling influence in the field of private business should govern the public business of highway improvement. Our highways, to insure their proper development, should be improved in accordance with economic and engineering facts and should not be influenced by political considerations.

Basic Principles of Highway Management.—The first basic principle of highway management is that the various sections of state and county highway systems selected for improvement and the class of improvement chosen for each section should be based upon present and expected future traffic demands, modified by the various physical and economic characteristics which affect the choice of specific construction types to be built on the various parts of our highway systems.

The second basic principle is the familiar one of the budget, upon which all financially sound industries operate. Applied to the highway business it involves (1) the determination of the yearly amount of funds necessary for the five or ten-year improvement plan and (2) the apportionment of the cost among those who benefit from the improvements and (3) provision through legislation for raising the required revenue to stabilize highway income over the period of the improvement plan.

This management must insure the expenditure of the money in accordance with a predetermined plan of improvement in which each route and section of a route is to be improved to the degree required by traffic and to no greater or less degree.

A plan of state highway improvement may materially alter the economic and social development of a people as a whole or any section thereof. The location and improvement or lack of improvement of a given route is of vital importance not only to the traffic of the immediate locality but also to the traffic of larger areas. The planning and construction of a connected system of state and county highways deal in fact with the destiny of localities and states, their agriculture, their industries, the growth of suburban areas adjacent to centers of population and the economic and social activities of a people. This is a tremendous social responsibility resting upon our state and county highway engineers.

The major problem involved is not one of the particular types of improvement or materials to be used in the construction of a highway, but rather whether to build or not, and how much highway service can be economically justified in a given area. Upon the proper solution of these problems depend the well-being and progress of a people. Considering the improvement of highways from this point of view, there can be no question concerning the necessity of developing scientific plans for highway improvement over a period of years in the several states and counties, and of providing the necessary funds to carry out economically the proposed plan of improvement.

Basic Facts for Scientific Plan.—What is the procedure and what are the basic facts necessary to lay out a scientific plan of state or county highway improvement?

1. The first step is the measurement of the present and the prediction of the future volume and character of traffic on state and county highway systems. The principal traffic factors involved in determining the relative traffic importance of the various parts of a highway system are average daily and maximum total traffic, average daily and maximum t o t a l t r u c k traffic and the number of daily loaded large, 5-7½ ton capacities, medium, 3-4 ton capacities and light, ½-2½ capacities using and expected to use each section of highway. Population density and distribution is of material assistance in preparing this analysis. This material is best summarized as a traffic classification of each section of state and county highways, showing those sections now carrying or expected to carry 1,500 or more daily vehicles during a five or ten year period; those sections carrying or expected to carry between five or six hundred and 1,500, and those sections carrying or expected to carry five or six hundred or less vehicles per day. Approximately these three classifications of traffic sections of a highway system determine the general classes of improvement necessary on each section of the system, gravel or similar improvements for the five or six hundred or less class; paved surfaces of the lower type for the five or six to 1,500 class, and the superior types of paved surfaces for the class of 1,500 or more vehicles.

2. The second stage of highway planning analysis is the determination of new highway locations or connections, relocation of present highways, and the elimination of the obstacles to the free movement to traffic based on the traffic classification data prepared

as the first step in developing the plan of improvement.

3. The third stage of a scientific analysis of a highway system is the valuation of the present highway improvements on the system to determine in the light of traffic data and the physical problems involved in improving the various sections of a system, whether the present surface is adequate, for five or ten years, has a salvage value for base material or is of no value as a part of the plan of improvement to be developed. The district superintendents and division engineers should first log each section of highway in their respective jurisdictions as to type, surface width, and highway right of way width. Then the present surfaces on each section of a route should be classified, based on the traffic classification for each section as follows: first class, adequate for ten years; second class; adequate for five years and indicating reconstruction during the succeeding five year period; third class having salvage value as base material and requiring reconstruction; fourth class having no salvage value and requiring new construction. This data should be carefully prepared since it forms the basis for the reconstruction program.

4. The fourth step is the determination of surface width for each section of highway based on traffic density and time rate analysis. It is obvious that sections of the state and county systems having less than a modern 2-lane surface should be included as a part of the plan of widening such surfaces. Those sections of the system carrying large daily volumes of traffic should be planned for additional width as a part of the widening program. It is doubtful if any considerable mileage of state or county highways will require more than 2-lane surfaces and it is also doubtful if any such highways should be planned for more than four lanes of traffic.

5. The next step is the determination of the new construction necessary based on the traffic classification.

6. The next stage is the analysis of present structures and the planning of new bridge and grade separation requirements during each of the five year periods.

7. The next step is the summary of the plan of highway improvement including new construction, reconstruction, widening, and structures.

8. The final stage is the establishment of the budget requirements for the ten year period based upon careful estimates of construction costs for each part of the improvement plan and the determination of the yearly construction, maintenance and administrative funds necessary to carry out a scientific, and orderly plan of improvement based upon facts.

When the above plan is completed it is essential that the public be made familiar with all the essential facts involved in the plan of improving their system of transportation and I am confident that when you have completed a thorough economic and engineering analysis of your system of highways, prepared your plan and budget based on facts and acquainted your public with the facts, that sufficient revenue will be made available to carry out successfully the plan of improvement.

Pennsylvania Association of Planning Comissioners 1928 Conference

The Pennsylvania Association of Planning Commissioners held their Third Annual Conference at Altoona, Pa., Feb. 16 and 17. This first conference outside of Harrisburg undoubtedly was a distinct advance in the interest of city planning and municipal development in the state. It was "bigger and better" then previous meetings, both from attendance of commissioners, other municipal officials and interested persons and programmed subjects.

The program was full and adequate, from registration 9 A. M. on the 16th till closing at 4:30 P. M. Feb. 17th. Altoonans: Mayor McMurray and W. A. Hoyt, Chairman, City Planning Commission, welcomed the delegates and, Dr. H. M. J. Klein, President of the association, responded. "Traffic Problems and Zoning in Altoona" were treated. Mr. Hoyt, covering the Financial Plan and Planning Engineer Arthur Richards, gave an Exposition of Local problems while F. Woods Beckman, Past President, Altoona Real Estate Board, dealt with the real estate developers phases.

Housing in the City Plan was presented by Benjamin H. Ritter, executive secretary, Pennsylvania Housing and Town Planning Association. John Ihlder, Manager, Civic Development Department, United States Chamber of Commerce, Washington, D. C., was the dinner speaker. His theme was comprehensive and stressed planning, zoning and traffic.

The forenoon of Feb. 17 was devoted to zoning. Contributions were made by W. C. Rice, Secretary, Pittsburgh Planning Commission; U. N. Arthur, Chief Engineer, Pittsburgh Department of City planning, and Frank P. Best of Morris Knowles, Inc., consultants Altoona Zoning Ordiance, proposed. During the afternoon Russell Van Ness Black, Planning Engineer for the Regional Planning Federation of Philadelphia Tri State District, spoke of Regional Planning. Thomas H. Reed, Director, Bureau of Government, University of Michigan, presented his theme on Regional Government. Francis J. Mulvihill, Chief, Division of City Planning and Municipal Engineering, Pennsylvania Bureau of Municipal Affairs, reported on progress of City Planning in Pennsylvania during 1927. Leo J. Buettner, Secretary, City Planning Commission, Johnstown, in his Making City Planning Effective demonstrated his talk with lantern slides.

The Three-minute Reports from planning commissioners, on their respective cities, covering their progress in the past year and their current progress, provided interest and variety; directed and stimulated pleasant surprises in unexpected incidental questions and discussion. These experiences, some involving trial and error, accomplish good and the commissions will avoid negations in the future. Seemingly there is increasing knowledge as well as understanding of city planning and its various phases. Appropriations are increased; money is being spent to save spending money. Financial, legal and social aspects are gaining attention in addition to the requisite of planning in relation to the ground or physical conditions. It would appear that "it is the best interests of their respective communities and they can well afford to give their best thought, consideration and energies to planning, whether it has to do with a small plan or lots, a neighborhood, community, borough, township, city, county or a region embracing separate units." Zoning and traffic congestion seemed most important of all the various elements of planning and development discussed. The conference next year will be held in Williamsport and it seems that the precarious existence of the Pennsylvania Association of Planning Commissioners is something of the past.

Kansas Has Removed 44 Grade Crossings

The elimination of forty-four railroad grade crossings twenty-nine of them on one highway and one railroad, has been accomplished by the Kansas highway commission in the last year, according to John Gardner, highway director. On U. S. highways Nos. 40 and 40-S, which follow the Union Pacific railroad entirely across the state, twenty-nine of the forty-five grade crossing of this railroad have been eliminated or contracts let to remove them.

When the work is completed on the U. S. highways Nos. 40 and 40-S the only grade crossing of the main line of the Union Pacific will be in Lawrence. Of the remaining sixteen crossings, two are to be eliminated by viaducts and three by subways and the others by rerouting of the highway.

Connecticut Raises $3,000,000 by Gas Tax.—More than $3,000,000 was realized from the state tax on gasoline in Connecticut during 1927. This amount is approximately $1,000,000 above the annual revenue which was expected to be derived from this source when the tax was increased by the general assembly in 1925 from 1 to 2 ct. a gal. An increase of about $376,500 over 1926 is reported for the last calendar year.

Surveys and Planning For Improvement of County Highway Systems

Committee* Report Presented at Recent Convention American Road Builders Association

THE report of Committee No. 1 on Surveys and Planning is based upon data obtained since the appointment of the committee, from county officials of various counties.

Due to the short length of time this committee has had in which to function it has been impossible to make a detailed survey covering every county, but we feel that the replies and data thus far received are fairly representative of the country.

In view of the fact that your committee has been in existence for less than one year, and that data obtainable have been meager for a matter of such national character, we do not feel qualified at this time to go into great detail and have avoided finely drawn conclusions, feeling secure in the belief that if the fundamentals of the plan are carried out the details will be a natural development.

As industry expands and the standard of living conditions is raised to a higher plane, the demand for public improvements has become so insistent, and economic changes are occurring so rapidly, that nearly every county in the nation is faced with problems calling for systematic county planning.

Systematic County Planning Needed.—In order that needed improvements may be planned to the best interest of the community, and with economy, each county should have a planning commission. Many of the wealthier counties—those having large revenue and rapidly growing communities—have such a commission. Reports indicate, however, that very few of the "average" counties, those having low assessed valuation or sparse population, have a well defined system of planning of improvements. The county planning commission is needed just as badly by the counties of the latter class as the counties whose revenues permit great expenditures. In the majority of cases where valuation is low, the mileage of roads is out of proportion to the amount of moneys available for road improvement. It is here as much as anywhere else that improvements and expenditures must be carefully and intelligently planned, for both the present and the future, in order that the public may enjoy facilities which they might otherwise be denied.

Personnel of County Planning Commission.—The county planning commission should be composed of the governing body of the county, and include the engineer or county surveyor, as the case may be, who should serve as a member of the commission rather than merely in an advisory capacity as is often the case. Where the engineer is a member of the commission he feels more free to offer constructive advice and suggestions and his recommendations carry more weight. When the engineer serves merely in an advisory capacity he usually does not feel free to offer opinions or recommendations unless called upon for the same, and being in a subordinate position, his recommendations are divested of some of the prestige to which he might rightfully be entitled by virtue of long experience.

Weaknesses of Appointed Citizens Committees.—It has been observed that some counties have a planning committee composed of citizens appointed by the governing body of the county. This system has many inherent weaknesses and we are disposed to recommend against it. The governing body cannot by delegation of authority, escape its responsibilities! No one is in better position to understand the needs and resources of the county than the county officials themselves and regardless of the system employed the citizens will hold them responsible for conditions prevailing in matters over which they have jurisdiction. The foregoing, of course, is not to be construed as a recommendation against the practice of appointing citizen committees to act in an advisory capacity with the planning commission.

Due to the fact that the members of such commissions are usually elected from general walks of life, and go into office without experience in administration and planning of county improvements, it should be most helpful if this Association prepare, adopt and recommend a standard set of fundamental methods to aid in intelligent county planning.

Before the planning commission can proceed with a well defined plan they must necessarily make a comprehensive survey of economic conditions, apparent needs, and the financial condition of the community, considering the bonded indebtedness, if any, the rate at which same will be retired and the resources of the county, at the same time endeavoring to forecast as closely as possible future conditions and requirements.

All this, as a general rule, calls for ability and experience of an order not usually found in those counties whose revenues do not permit compensation sufficient to attract engineers and others who specialize in such matters. Lacking such training themselves, it is only natural that they would be glad to profit by the experience of others and adopt, at least to some extent, methods which are known to be efficient and which will produce satisfactory results.

Economic Surveys by County Planning Commissions.—With this in mind your committee would recommend that simultaneously with the adoption of standards for county planning, the association likewise adopt a standard set of methods and procedure in economic surveys by county planning commissions.

Virtually every county is faced with the problem of expanding its highway system laterally while endeavoring to improve its main roads between important points. Great economic changes are taking place over the country, which while gradual, nevertheless must be recognized and improvements planned accordingly if the county is to retain a place among the progressive communities.

Particularly, in those communities where soil is fertile and the population is not dense, a change is taking place in the gradual settling up of the land by additional population migrating into the county. As a result of this we observe expansion of towns, rural subdivisions, and increased traffic, all of which is a forerunner of more homes, better markets, business building and intensive improvements. Each year we see many miles of county highways change in character from rural roads to city streets.

The Narrow Right of Way Problem.—County highway standards considered ultra-modern a decade ago are practically obsolete today. Not only are our pavements narrow, but we are in possession of thousands of miles of narrow right of way and of roads poorly located. Residents of the counties which have heavy intercity traffic know of the inadequacy of the pavement and roadbed widths and of the costs of widen-

*Committee on Surveys and Planning, County Highway Officials Division. The committee consisted of Stanley Abel, Supervisor Fourth District, County of Kern, Taft, Calif., Chairman; W. F. Cavanaugh, County Highway Commissioner, Milwuakee, Wis.; A. L. Micou, County Engineer, South Boston, Va.; E. L. Clemmer, County Road and Bridge Engineer, Uniontown, Pa.; B. W. Davis, County Engineer, Nashville, N. C.; W. F. Kruckeberg, County Surveyor, Stanford, Mont.; E. M. Dean, c/o Wilson & Dean, Richfield, Kansas; Theodore M. O'Neal, Chairman, County Commissioners, Delray, Fla.; Robert T. Johnson, County Engineer, Knoxville, Ia.; Jack Selemeyer, Supervisor of Roads, Clarksville, Tenn.; F. Norvell Larkin, County Engineer, Fairfax, Va.; J. R. Wendt, Parish Highway Engineer, Benton, La.; H. W. Nixon, County Engineer, Logan, O.; C. J. Rogers, County Highway Engineer, Birmingham, Ala.; T. E. Huffman, County Engineer, Laredo, Tex.; James A. Reynolds, Chief Engineer, Palatka, Fla.

ing the same. Millions of dollars are being expended annually for the widening of highways and boulevards, much of which could have been saved by a little systematic planning a few years ago.

Subdividers of rural territory along county highways are prone to lay out their subdivisions with a minimum of right of way width along the highway. Especially is this the case where the road has been established by public usage and the county has no definite width of right of way. Rural estate fronting upon a highway is usually most expensive and most intensively improved, thus it follows that when later conditions demand the widening of the roadway the county usually has to condemn, and pay for, some very expensive right of way.

With this in mind we strongly recommend that this Association endeavor to effect appropriate legislation, in those states which do not already have such laws, which will require as a pre-requisite to the sale of lands within such subdivisions the filing of a map and approval of the same by the governing body and planning commission of the county.

Budgeting Public Improvements.—Assuming that we should, as rapidly as traffic and commerce demand, secure more roads, the question immediately arising is, How? The geographical location of roads in relation to industry and population to be served is naturally of prime consideration. Considering the matter of geographical location as satisfactory, we are next faced with the problem of how such public improvements can be secured. The extent of improvements of which a county is capable depends upon practical limitations. In addition to road improvements there are countless other expenses which must be borne by the county each year. All of this comes from taxes. There is, however, an equally large tax bill in the form of public improvement assessments in some states where local improvement acts are used extensively. All this comes out of the pockets of the taxpayers.

There are numerous places over the country where the taxes are considered burdensome because of the combination lic improvements. Instead of being constructed under a systematic and proof tax levies and assessments for pubgressive plan these improvements have usually been delayed for years until insistent demand produced a reaction resulting in a wild orgy of elaborate improvements with the consequent burden of taxes and assessments. To eliminate such conditions in the future we must budget our public improvements.

Such conditions could be and should be prevented by a consistent and sane plan of public improvement, budgeting all plans of expenditure for improvements and taking them in the order of their necessity.

The Assessment Map. — A map should be prepared which will show all assessments now in existence and all major projects proposed. A general map should be prepared which will show the density of assessments and all improvement districts, if any. Only when the planning commission has such data at its disposal can it decide intelligently upon the practicability of each proposed improvement. No county can meet over-night the costs of all improvements deemed necessary. The means available must be considered upon the basis of a common-sense business plan. We must not use up all our available resources in one public improvement lest we be prevented from securing other improvements of equal or greater importance. Thorough and consistent planning can not be had without proper regard for a sane budget of all county improvements, based upon priority determined by necessity and desirability.

The part played on paper in county planning is that of presenting a clear and intelligent picture of every detail of the subject for all concerned. A comprehensive record of all known facts of sufficient importance to have received the attention of the planning commission is of inestimable value to the commission for future reference as well as for present consideration. Such data will often protect the commission in its conclusions and frequent embarrassment of the commission can be eliminated if their position is clearly depicted and supported by a graphic survey of record.

The County Road Map.—Each county should have a road map showing all roads in the county system, and showing federal and state highways. All county roads should be numbered in conformity with the plan for numbering national highways and standard designs of highway markers should be installed so that travelers from any part of the United States may readily identify county and state highways. County roads should be divided into primary and secondary classifications according to their purpose and usage. Primary roads would be trunk highways connecting important points, while township roads or laterals to the primary system would lie in the secondary classification.

For convenience in folding and filing road maps should be made in sizes which are multiples of letter head size, that is, in sizes which are divisible by eight and one-half inches in one dimension and by eleven inches in the other dimension.

Standard Plans, Specifications and Contracts.—Each county should adopt standard plans, specifications and contract forms where same has not already been done. In those states where it is customary for counties to use state highway department forms, the counties should formally adopt such standards as are applicable to local conditions, with appropriate modifications as conditions warrant. Of course the sizes of plan sheets would be multiples of letter head size as heretofore mentioned.

Copies of specifications received by this committee from various counties indicate the desirability of a standard size for specifications. Most printed copies received to date have been printed in various bookbinder's sizes according to the taste of the printer or the department having them printed.

In co-operation with the efforts of the U. S. Department of Commerce all such specifications and other printed forms should be printed in standard letterhead size for economy in filing. Odd sizes are great wasters of space unless filed in special cabinets, and the later practice is more expensive than using standard letter size cabinets.

Due to difference in the statutes of the various states this committee does not feel competent at this time to draft a universal contract form but we feel that uniform contracts and procedure should be urged upon the counties of each state, which would result in considerable saving annually.

Recommendations of Committee.—In conclusion, Committe No. 1 on Surveys and Planning, sumarizing, begs to submit the following recommendations:

1. That the American Road Builders Association recommend a planning commission for every county, composed of the governing body and highway engineer of the county, with advisory board if local conditions warrant.
2. That the association gather all available data upon the subject and assist in the movement by furnishing forms, information, etc.
3. That the association adopt standards for county planning.
4. That the association decide upon and adopt standard methods and procedure in economic surveys by county planning commissions.
5. That standards be adopted for the prepartion of county road maps showing different types of improvements.
6. That the association go as far as possible in the preparation of uniform specifications and contract forms, and methods of preparing plans and make the results of same available to all counties.
7. That the association endeavor to effect legislation which will require as a pre-requisite to the sale of lands within subdivisions outside of incorporated cities, the filing of a map of the subdivision and the approval of the same by the planning commission of the county, where such legislation is not already in force.

Street Opening and Widening Improvements at Los Angeles, Cal.

Their Effect Directly Reflected in Form of Increased Values of Abutting Property

By JOHN C. SHAW
City Engineer, Los Angeles, Cal.

THE city of Los Angeles, like many other cities, is faced with an extensive program of street opening and widening development, in order to provide for constantly increasing vehicular traffic. The opening of new main highways and the widening of existing highways is of unquestionable benefit to the general traveling public. This form of improvement, is, however, a matter of considerable concern and conjecture as to whether the effecting of new improvements of this character is directly reflected in the from of enhanced values to abutting property, at least to the extent of the cost of the improvement, in which event the improvement may be regarded as a sound business investment.

Effect of Widening in Residential Section.—This feature of increased values, in some cases, may or may not apply, particularly where a street is widened which traverses a highly developed residential section. It can readily be seen that the forcing of a greatly increased volume of traffic along such a street may, in some cases, be detrimental. If we consider the development, and use to which the property along the street is put, the forcing of traffic through such a district might tend to break down rather than improve the conditions of the district in general. We have some instances of this kind in this city. One, particularly, occurs to me, that of a beautiful avenue, some ten miles in length, most of which traverses strictly residential property, and highly improved in this respect. In some cases, of course, it is impossible to prevent the breaking up of residential districts, particularly if such districts lie within or adjacent to sections rapidly changing as a result of the encroachment of business and apartment buildings. This is especially true if the proposed widening has been planned in advance and is a part of the general traffic plan.

The Policy at Los Angeles.—In the past few years, this city has adopted a policy to the effect that in cases where new highways are to be opened or widened at a width of either 80 or 100 ft., or more, the same are, to a certain extent, of city wide interest and importance, and therefore merit a contribution from public funds of a portion of the cost of effecting such improvement, the proportion of such allocations ranging from 10 to 20 per cent of the total estimated cost. The remaining cost is assessed against a local district, embracing such territory as may be regarded as directly benefiting from the establishment of the new highway.

In the case of this city, a comprehensive plan of highway development covering the entire city was adopted by vote of the electors in 1924, based upon a careful study of the present and future traffic requirements. A limited number of these projects, regarded as of most value to traffic, have been selected for immediate consumption, and the remaining projects will be worked toward in conection with the future growth and traffic increase, and taking into account the extent of such a program that the city is able to finance at one time.

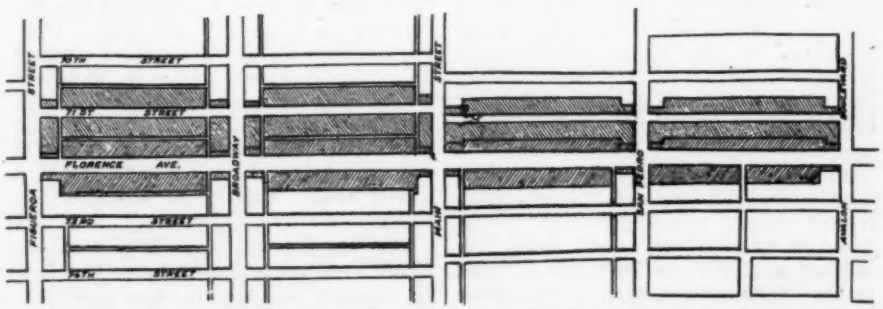
The Widening of Florence Ave.—The case of Florence Ave., in this city is cited to show the effect of a main highway widening upon the values of the adjacent property. This street is included in the major traffic street plan of Los Angeles, previously referred to, but the widening proceedings were initiated in the year of 1920, or four years in advance of the adoption of the general plan. The section of Florence Ave. referred to is one mile in length, between Figueroa St. on the west and Avalon Blvd. on the east. It follows a section line and is located about five miles southerly from the heart of the present retail business district of the city. Previous to the institution of the widening proceedings, Florence Ave. was 60 ft. in width, and was widened to a new width of 100 ft. by the acquiring of 20 ft. strips of private property along each side thereof. As a matter of comparison of property values, the case of 71st St., which parallels Florence Ave., one block northerly, is also cited. This street is 60 ft. wide, or the width of Florence Ave. previous to widening.

Increased Assessment Valuation.—The following tabulation indicates the aggregate assessed valuation, taken from the county assesor's rolls and made for the purpose of local taxation, covering both of these streets for the years 1920, 1923 and 1927. 1920 is the year in which the opening and widening proceedings for Florence Ave. were first instituted by ordinance. 1923 is the date of the completion of the condemnation suit. The paving of the street, as widened, was completed in 1926.

	1920	1923	1927
Florence Ave.	$70,780	$138,510	$366.010
71st St.	$59,290	$113,950	$198,020

The actual value or selling price of the property is from 2½ to 5 times the amount of the assessed value as represented by the above figures. During the period from 1920 to 1927, the increase of all property fronting on 71st St., as indicated upon the accompanying map, was 340 per cent, and on Florence Ave., the property value increase amounted to 520 per cent.

What an Analysis Shows.—An analysis of the above figures would indicate that 71st St., one block removed from Florence Ave., has been subject to more than the normal property value increase due to its proximity to the street actually widened, and that in the case of Florence Ave., the similar increase in values of 520 per cent clearly indicates that such increases is directly traceable to the effect of this widening improvement. The adjacent property owners along Florence Ave., who paid the major portion of the cost, are highly pleased with the improvement. This street, which a comparatively short time ago, was a country lane, with a few old time residences along the same and a little business activity at the principal corners, has become a



Map Showing Location of Florence Ave. Widening Development and Property Affected by It

main highway, with a roadway paved 74 ft. between curbs and a system of ornamental lights installed along the same. Traffic has vastly increased and business establishments are springing up, not only at the corner, but also along a considerable proportion of the inside lots.

The above county assessor's figures do not represent the total increase in values along this street, as the assessor follows a policy of being somewhat conservative in the making of too radical changes in property assessments, rather allowing the property a little time to develop its potential possibilities before immediately subjecting it to a high tax rate, so that the actual increased values are far in advance of those quoted herein.

From the experience of the above street, and this applies also to many other streets where like improvements have been made, the consumption of this necessary public improvement was a sound business investment to the property owners themselves.

Stone Roads

Suggestions Given in Paper at 14th Annual Purdue Road School

By C. W. McCLAIN
District Engineer, Indiana State Highway Commission

I WILL give a few suggestions to road men having in charge the maintenance of stone roads who do not have access to a testing laboratory.

Selecting the Material.—All good road metal starts at its source. No testing laboratory is necessary to detect objectionable shale, soapstone, and sandstone. This can be done at the quarry by anyone having even a rudimentary acquaintance with limestone. Two qualities almost always spoken of in laboratory tests of stone are hardness and toughness. These at first thought may seem like confusing terms, yet one quality without the other makes for poor road metal. Every road is constantly being subjected to a grinding action, either from the action of steel tired vehicles, or the rubbing action of one stone on another. In order to resist this grinding action the stone must possess the quality of hardness.

The surface is also subjected to pounding and impact action which tends to break up the metal into smaller pieces. In order to resist this action the stone must possess the quality of toughness. Remember the two destructive actions, grinding and breaking. A hard stone may be so brittle as to be almost useless and a tough stone so soft it will readily grind into dust. With these in mind a very good visual and manual analysis can be made of road metal. Take some section of your stone roads that holds up exceedingly well and see if you do not notice these two qualities prominent.

Another thing to be looked for is the cementing value of the stone. A road that won't pack or one that grinds up into dust are both objectionable. If the proper hardness and toughness are secured this cementing property will take care of itself. If you have a road that ravels or one excessively dusty look for the remedy in the quality of your road metal. No set rule can be laid down for this selection but experience and close study are neecssary for results.

Placing the Metal.—After the proper material has been selected the next thing is to get it on the road. I am sure all of you have seen the wrong way to dump road material on the road surface. The common practice used to be, and I am sorry to say, in some places still is, is to dump the whole load in one place. The next load is done the same way, usually leaving 2 or 3 ft. between the end of one load and the beginning of the next. I think nothing need be said about the riding qualities of such a road. The metal should be uniformly and evenly scattered. If the base is strong enough remember you are only replacing the wearing surface by the addition of metal.

The stone should always be put on at such times of the year when it will readily incorporate with the surface. Recognition of this one fact alone will save many dollars in road metal and your road will correspondingly grow better. One yard of metal up where the traffic runs is worth many yards along the edges, on the shoulders or in the side ditch. Where you dump the metal is usually where you want it, so every advantage should be taken to keep it there.

If put on at the proper time a larger aggregate can be used. By this use of larger sizes a sturdier road will result. If the surface is not in the proper condition to receive a larger aggregate and it is put on, it will roll around on top and be very objectionable.

The principle of dragging and planing is so well known among all road men I am purposely omitting any further mention of it. The best way to have a smooth stone road is to keep it smooth. Once a stone road surface gets rough it is difficult to get it back in good condition. Great care should be taken that all stone surfaces go into the summer in a smooth condition. During the summer months a stone surface gets almost concrete-like in hardness and a drag or maintainer cannot have the smoothing action it would have on a graved road. A stone surface is not so subject to "chatter bumps" as is a gravel road. This is one of its advantages.

While many good qualities, the stone surface has some objectionable features. In summer the dust is very objectionable, both to the travelers' comfort and safety, and to the people living along the road. The farmers' crops, especially his forage crops adjacent to the road, are practically ruined if a rain does not immediately precede his harvest. The dust will penetrate into the houses and cause housekeepers much annoyance. While not holding a brief for any particular type of road, I do know that the presence of stone in my district has kept many miles of roads out of the mud and in good driving condition, where otherwise these same miles of good roads would never have been built.

In conclusion remember that stone can make an excellent road if properly selected, applied and manipulated. Have clearly in mind what you want when selecting your quarry, the condition of your road when applying the metal, and forecast the season's demands when manipulating it. Remember a stone road going into the summer as a smooth road is more apt to stay smooth. Finally if a road is smooth, as far as the traveling public is concerned, many other defects are readily forgiven.

Adequate Lighting Would Double Night Use of Roads

Two per cent of a state highway investment if spent for adequate illumination would double the night use of roads and largely increase the usefulness of highway systems, according to an article in the Transactions of the Illuminating Engineering Society.

"Two knotty traffic problems which become more insistent every year are highway congestion by day, and glare by night. Adequate highway lighting would be at once the practical and economical solution of both.

"Let us consider this form an economic standpoint. The automobile investment of the United States for 1926 is estimated at ten billion dollars. It costs twenty to fifty thousand dollars to build a mile of highway. To light it costs about seven hundred dollars a year.

"On a basis of thirty-five thousand dollars a mile cost, for 2 per cent of the state highway investment, spent in adequate highway lighting, it is conservative to estimate that the night use of roads would be doubled. Night traffic is now 18 per cent of the total, and doubling this would increase the present efficiency of the highway system by at least that percentage."

Paving Work in Iowa Cities in 1927.—Sioux City occupies first place among cities of Iowa in respect to the amount of paving construction work done in 1927. Figures for the highest cities follow: Sioux City, 335,414 yd.; Clinton, 123,180 yd.; Burlington, 88,508 yd.; Ottumwa, 65,731 yd.; Davenport, 63,367 yd.

The Development of a Highway Transportation System for a County

Committee Report Presented at Recent Convention American Road Builders' Association

By CHAS. E. GRUBB, Chairman.
County Engineer, New Castle County, Delaware

Construction is a most important step in the process of developing a highway transportation system whether for a nation, a state, or a county. The purpose of roads in each differ somewhat, yet in all the fundamental principles are identical. In each the governing board should aim for the best economic purchase of roads that can be maintained at a minimum of cost and at the same time furnish to the taxpayers satisfactory means of transportation whereby traffic may operate at a minimum of expense.

Problems Primarily Engineering and Economic.—The problems are primarily engineering and economic in nature. Before actual construction is undertaken, a very thorough and careful analysis should be made of the traffic needs, present and prospective, the financial resources and the possible returns from an investment in highways for the whole territory for which a system is to be provided. These returns should be measured by the probable influence of the improved transportation facilities upon the daily lives of the individuals of the full area for their economic, civil and social advancement.

From this it will be observed that the term construction should be taken to include all gradations of improvements from the simplest change of the native road by shaping or grading to the laying of the highest type of pavement.

Wide Variation in County Policies.—The committee finds the widest variation in policies and results in respect to county highway construction. There are numerous outstanding examples of accomplishment in county highway development on a sound economic basis. Among counties of certain particular states and topographical areas there have been coordination of efforts and standardization of practices. Where such has been in effect, greater uniformity of results is apparent and generally higher standards prevail. In other counties no systematic construction of highways has been undertaken.

It is, of course, to be expected that greater variations will continue to occur in county construction than in state construction because of the direct influence of local factors. However, we believe that a comprehensive study of the situation and the exchange of ideas through the medium of this division of the A. R. B. A. will point the way to a more intelligent local application of the general economic and engineering principles. In this manner the counties will be materially assisted in the development of secondary or auxiliary systems of highways which will more effectively supplement the federal aid and state highway systems and in a greater measure extend the benefits of these even to the furthermost agricultural sections of our country.

Early Road Building Local Problem.—From the beginning of our nation, control and responsibility for road and bridge matters have been largely problems of the local government. The present good roads movement stimulated by the Federal Aid program and the organization of state highway officials has brought about a centralization of authority and accelerated the construction of highways on the primary routes in every state.

Previous to this general development by states, highway development was undertaken in many of the wealthier and more populous counties. Mostly these were located immediately surrounding or containing cities of industrial importance where the necessity of better roads was early apparent. As later developments in highway construction have occurred, most of these pioneer counties have kept pace.

Their operations are directed by well organized engineering departments with executives and assistants of technical ability. Their standards are in full accordance with the best modern practices as to general plan, design and construction details. Having commenced construction at a time when the traffic demands were light, these counties have, with the great changes in character and volume of traffic, found it necessary to replace or reconstruct many of their early roads and, therefore, during recent years have not greatly increased their improved mileage. Along with the states undertaking construction at an early date, these counties have found it necessary to build sturdier and sturdier highways in successive years.

Naturally costs have mounted in direct proportion to these additions in the type of improvement. Possible reductions through improved methods and facilities and lowering labor costs effected since the war have been absorbed and in some instances exceeded by additional construction requirements.

Higher Type of Construction Required in Certain Localities.—Within close proximity of industrial centers and other districts where the frequent rambling of heavy auto trucks and trailers is a daily occurrence, it is apparent that none but this highest type of road will withstand the traffic. Any other type of construction would soon prove to be a liability rather than an asset. Here the best road is none too good. Any road worth building at all may just as well be built in accordance with the highest type standards in the beginning; the only difference in such a territory between a main highway and a by-road being the width of the pavement.

However, the cost of the generally accepted higher type of construction of today is beyond the ability to pay of almost every community, except these special areas, if any considerable portion of its mileage is to be improved.

Today, less costly types are also being constructed and it would seem that there is a definite tendency in highway construction toward such lower cost construction, particularly for county highway development.

Better drainage methods, more thorough knowledge of construction materials, improvements in the grading and combining of aggregates and the composition of binders, especially tars and asphalts, have been brought about by reason of research. During this same session such low cost construction will be covered in a paper to be presented by Mr. Conner of the Highway Research Board. Having devoted considerable concentrated attention to this class of construction, he is most ably qualified to discuss the subject and we believe his conclusions merit thorough consideration.

The Low Cost Roads.—We would caution, however, that decision in respect to choice of roads of this character and their actual construction require the same expert study as the most costly types. The low cost roads must not be accepted as a solution of all road problems. They have rather definite load limitations and are more susceptible to damage from climatic changes. Care should be exercised that full advantage is taken of the experiences in light road construction in districts undertaking construction in earlier years and the mistakes of these areas are avoided, both as to manners of financing and methods of construction.

Centralization of Control.—The question of centralization of control as to road construction is largely a local problem. The scope of work should

certainly be large enough to warrant the employment of a competent engineering staff and yet small enough to admit of the directing head being familiar with the general needs of the area for which a system of roads is to be provided.

There has been, in the past, probably a lack of appreciation of the earnestness, sincerity and seriousness of the county authorities in coping with complicated highway problems, especially during the period of radical highway transportation changes. At this time there was an absence of any research solutions of highway problems or even joint consideration of them on any extended scale.

As the magnitude of the transportation difficulties gradually became apparent, individual state action was followed by national attention to the problems involved. Our federal aid law was enacted and by it the remaining states were encouraged to organize for highway construction. Through this transitory period the failures rather than the successes of county activities were emphasized.

Such handicaps as indifference on the part of the public generally and fear of increased taxation on the part of the farmers were not mentioned. State and federal participation has provided connected systems of primary routes and aroused the public to a more general realization of the value of improved transportation facilities. Also the general use of the automobile has revolutionized the economic aspect of highway improvement.

Counties which a few years ago could afford but a most meager road investment can today not only afford the development of a system of highways but face the necessity of providing such for their continued economic existence.

The responsibility for their development should not be shifted from one jurisdiction to another merely for the purpose of shifting the financial burden or for political reasons. Any division of responsibility must necessarily be somewhat an arbitrary one, but it should be based on generally sound economic principles.

When divided or joint responsibility between a state and its counties for any portion of highway development is decided upon, it would seem best to limit the participation by one unit to such general features of approval of bonds or program for procedure and concentrate the actual direction and responsibility for all other details upon the other, preferably the superior unit.

If divided responsibility be carried too far into details, such as to choice of road type and supervision of construction, it inevitably leads to controversies, costly delays and inferior compromised results—results entirely unsatisfactory and economically unsound. Centralization may also be carried too far, particularly where there is a strong contract in the demands, needs and resources of different districts of the same state.

General Plan for Centralization.—As a general plan in respect to centralization or division of responsibility for highway development it would seem safe to prescribe only such subordination of the local units as may be necessary to secure competent engineering direction and supervision with close coordination of efforts among all the various governmental units involved in providing complete highway development.

In some sparsely settled localities where, because of small transportation needs and lack of resources, improvements except on through routes must be small, development of the area of a whole state may properly be centralized in one board; yet even in these states, mostly of the South and West, the vastness of the areas and the great mileage of roads in them dictate the advisability of smaller units of control. Where there is the immediate need for intensive highway development as in thickly populated and wealthy districts, even a township may be in position to support a properly organized highway department to function economically, the township in this case serving more as an extended city.

Also where there exists a wide variation in the needs of the different districts of the same state, local control through township or county department will possibly operate to the satisfaction and benefits of the larger number. In this scale of directing units of government the county occupies a middle position, and it should seem likely and entirely appropriate that upon counties generally for many years to come would rest the responsibility for further or intensive development of the vast mileage of rural highways.

To a very large extent the improvement of roads or the state of development of a road system in every community today is about in keeping with the education, demands and willingness to pay of its majority interests. The extent to which the benefits of the connected through systems of state and federal aid highways are made available to the respective counties, depends to a great degree upon the initiative of the individual residents of them.

Closer Cooperation Between State and County.—However, the committee feels that the increasing transportation needs of every territory can be more satisfactorily served if closer cooperation between the states and their respective counties as well as between adjacent counties, be firmly established. The benefits which this cooperation—founded on mutual confidence—might secure are far reaching indeed, and through this division your committee believes that the opportunity to foster a spirit of such is presented.

Fair-minded state and county administrative boards conscientiously desirous of forwarding the interests of their districts and guided by well qualified and technically trained executives, recognize the necessity of the best business methods in a road construction program.

Such a group should serve as a board of directors, deciding questions of finance and policy and describing and delegating to its engineer the actual management of its business. Confidence should be placed in his judgment and be held responsible for the results obtained.

Types of Construction.—Standard types of construction are fairly well determined and results from any of them can be rather definitely anticipated. The choice of the type of construction, however, for any road or system of roads is a most difficult decision and in this the best service may be rendered to the road public. In thickly populated districts where commerce and industry have already taken the lead, it is evident that only the highest type of road should be constructed.

In localities where traffic is light, it is also evident that not only will the investment of one of the higher types of construction be unwarranted by the returns therefrom but very likely roads of a moderate cost will serve traffic demands for a number of years. The decision as to choice of construction type is influenced by such variables as location, population, topography, soil, local materials, latitude, character and volume of traffic, available funds, resources and legislative restrictions. Mainly among these factors are the character and volume of traffic, careful analysis of which requires a survey. From such survey and painstaking studies an estimate of the returns that a road or system of roads will net may be approximately determined and a program for construction decided upon.

Stage Method of Construction.—Many rural counties today are turning to the progressive or stage method of construction which has been attended by remarkable success in the state of North Carolina. By this plan, improved road service over the whole terirtory is provided from the beginning, even though for a very large percentage of the mileage this includes only the shaping of the native road. Immediate benefits may thus be given to all portions of the county and a more general support of the construction program obtained.

The next step which can be taken on any road is to provide for necessary changes of alignment, grading and installation of good drainage features. These should be constructed as nearly as possible to coincide with the hard surface road standards. At this same time, according to the extent of funds available and the immediate needs of the territory, construction of higher types as may be determined appropriate for the most important roads, can proceed. On the progressive type of roads, right-of-way should be secured suffi-

ciently wide to provide a minimum of thirty feet between gutters and to admit of full width development on those so located as to indicate their future use as trunk lines.

Grade crossings, as far as practicable, should be eliminated either by relocation of highway or railroad or construction of a bridge providing for a separation of their grades.

As a feature of construction, adequate protection should be provided for traffic at those grade crossings which cannot then be avoided and the approaches to them should provide clear view of both the highway and the railroad.

High curves should be banked to admit of the movement of traffic at a high rate of speed without danger of skidding.

As far as possible, adequate drainage by suitable pipes, culverts, and bridges should be provided for in the same manner as desired for the final development without regard to the stage of construction. Then, as the community develops, the stage constructed roads can be added to, approaching as the final result, a high type of hard surface road without loss of any step of the successive stages of development.

Regardless of the type of construction, too much emphasis cannot be placed upon the necessity for thoroughness in the actual building of the road. The nature of road construction causes the representatives of the highway department to be scattered over a wide area. It is, therefore, necessary to coordinate and control the organization closely to secure uniform methods of construction and be assured of the best results.

The Duties of the Construction Engineer.—The construction engineer should be fully conversant with the details of the work and sufficiently well qualified to interpret the plans and specifications clearly and in a reasonable manner, avoiding needless refinement, but requiring strict adherence to the important features of construction. He should see that all necessary stakes are set in advance of the work, that these check with the plan and that possible necessary changes to cover special conditions of drainage, etc., are anticipated well ahead of the construction.

In other words, to avoid unnecessary inconvenience and to reduce delays the engineer should not only follow the construction but be ahead of it and direct its progress. His personal influence should be impressed upon the contract for the best speed and quality of work. The engineer and contractor should determine upon a working schedule, establishing dates for accomplishment of the different stages of the work showing possible completion well within the designated time.

Testing Materials.—As far as possible, testing of materials, such as asphalts, tars and cement, should be arranged for at the source by reliable testing engineers. This plan reduces hold-ups in the field pending tests and gives the assurance that sampling and testing will be performed in a standard and uniform manner. Field judgment of other materials should from time to time be checked by laboratory tests. Snap judgment has in some cases condemned entirely satisfactory materials and in other cases, particularly in concrete work, imposed upon the contractor a loss of production and obtained an inferior pavement through improper grading of coarse aggregate.

In the following of the construction the engineer should be assisted by competent inspectors. Generally high-class talent in engineering design and field engineering is otbained, but when it comes to the actual inspection and incorporation of the materials in the roadway, the operations are still too often inspected by a man of insufficient experience.

This condition adds to the expense of the contractor, delays the completion of the work and produces results not in keeping with the design. A competent inspector is without question well worth any likely increase in salary over that paid the inexperienced one. The engineer can facilitate inspection and improve results thereof by underscoring the most important paragraphs and words of specifications submitted his inspectors and by outlining particular items of the successive steps of the work for special attention. Where a large number of inspectors must be trained, it is well to assemble them as a group from time to time for detail instruction as a class.

Progress Reports.—Reports stating the progress of the various items of work, weather conditions, number of workmen on the job, equipment in operation, material received, material consumed and other pertinent information or remarks to permit the office to keep in touch with the contract, should be prepared and submitted by the inspectors daily to both the field engineer and the control office. On concrete work it is usual to require that the empty bags be counted and reported as a check against the yardage laid and the proportions or yield of the mix.

Current estimates to be prepared by the field engineer, including all work performed as may be determined from daily reports and field observation without accurate measurement, should be submitted and paid promptly at regular intervals. The final estimate should be compiled and paid immediately upon the completion and acceptance of the work. Prompt payments permit contractors to discount bills and to account for their operations in a better business manner, securing in turn for the county, lower quotations on subsequent contracts.

Pavement Guarantees Unwarranted.—Pavement guarantees for periods of time following completion are unwarranted if the work is constructed under competent supervision and in accordance with well drawn specifications for a generally accepted standard construction. Such a provision whether supported by a bond or a cash retention definitely increases the contract prices of work. It is offered by the contractor or his foreman as an excuse for deviating from the specifications in important details. Another objection to this requirement is its interference during the guarantee period with the proper maintenance of the road, a feature directly affecting the service and life of the road itself.

In concluding our report we would emphasize that compared to the vast mileage of roads untouched by construction of any character the present county activity and the widespread Federal aid and state construction might be considered as merely a scratching of the surface of the final highway development of our country. From the present undertakings the impression is often gained that road building is keeping pace with other activities, whereas just about enough miles of new pavement are being added each year on which to park, end to end, the new automobiles purchased. We have a few hundred thousand miles of improved roads and millions of miles of roads suitable only for buggies and wagons —for a day that is dead in America.

Counties Control Great Mileage of Unimproved Roads.—The great percentage of this unimproved portion is under the jurisdiction of the counties. The rolling stock of our transportation system has been purchased and placed in commission on some 3,000,000 miles of roads—narrow, crooked, with sharp curves, heavy grades, flimsy bridges and culverts, dusty in dry weather, slippery, heavy and often impassable after heavy rains or, if rock surfaced, so rough that tires are soon worn out, bodies and machinery racked and passengers fatigued.

To overcome this condition of affairs is imperative. The rate of growth of our nation industrially, commercially, agriculturally and socially, depends today more upon improved highways than any other economic aspect. Here, then, is a challenge to the county authorities.

New International Highway Proposed.—The construction of an international highway, linking the United States with Central South America, is provided for under the terms of a bill introduced in the Senate by Senator Tasker L. Oddie of Nevada. The purpose of the highway, which is sponsored by the American Motorists Association and other organizations, would not only be for better highway facilities and communication between the countries, but would be conducive of good will, Senator Oddie declared in introducing the bill.

Resurfacing Old Stone and Gravel Roads With Bituminous Retread Top

Work Carried out Last Year in Indiana Described in Paper at 14th Annual Purdue Road School

By A. H. HINKLE

Superintendent of Maintenance, Indiana State Highway Commission

THIS type of surface may be described as a surface between the surface treatments or mulch mixtures and a bituminous macadam (penetration) top. I shall describe same by giving a specification for this class of work.

Specifications for Bituminous Retread Top

1. **Description.**—This bituminous retread top shall consist of a mixture of bituminous material and crushed stone, slag or gravel, made by applying successive applications of the bituminous material to a layer of aggregate spread on the old road to a smooth surface and a uniform crown and grade. The mixture is kept smooth and uniform, by the use of a grader or planer if necessary, until the bituminous material hardens sufficiently to cause the stone to compact under a roller. The aggregate is rolled after each application of bituminous material when the bituminous material is in the proper stage of curing. The surface voids that can not be closed by rolling, after the second application of bituminous material, are closed by the addition of No. 4 aggregate.

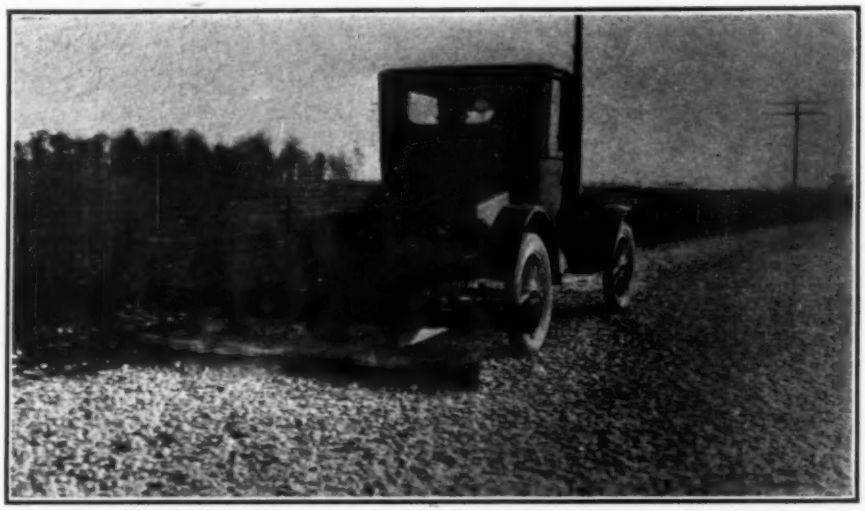
2. **Preparing the Old Road As a Base for the Retread Top.**—The old gravel or stone road shall be leveled and trued up by dragging, and scraping. A coat of No. 3 or No. 2 aggregate shall be applied if necessary to strengthen the old base. Scarifying before leveling may be resorted to if there is an abundance of coarse aggregate in the old road. (However, since the old road is usually weak it will generally be found more economical to build up the low places rather than cut down the high places.) After the old surface has been brought to proper grade and crown and after a sufficient thickness of base metal has been obtained, and the base is compacted either by traffic or rolling, the road is ready for the retread top. (If metal is added to level and strengthen the old base, it is preferable that it be done several months in advance of putting on the retread top so that a smooth and uniformly compacted base without much loose fine material thereon will result.)

If there is any material amount of fine aggregate such as sand or crushed stone on the old road after it is prepared for the retread top aggregate, same shall be uniformly distributed over the road surface so that it will not work up into the coarse aggregate non-uniformly. (Any spots in the coarse aggregate that are filled with this fine aggregate will likely develop into "fat" spots after the bitumen is applied. Such spots will be a source of trouble later on.) In some cases this excess loose material on the old surface has been treated with a light tar or asphalt oil thus solidifying the loose material and producing an impervious layer before the retread stone is placed thereon.

3. **Bituminous Materials.**—The grade and amount of bituminous material used in this work shall depend upon the depth and grade of aggregate. (No more shall be used than just sufficient to prevent reveling of the surface.) the table in Paragraph 9 (Table I) shall be used as a guide in determining the quantities to be used. If the aggregate contains much fine material, the first coat of bituminous material should be Liquid Asphalt ACG, Tar TC or TCM instead of the grade given in the table. The successive coats of bitumen shall follow each other just as soon as time for curing of the preceding coat has been allowed. Distributor and application shall comply with specifications in Item 5 for Bituminous Macadam Top.

4. **Covering Material.**—Covering material shall consist of grade A crushed stone, slag or gravel, size No. 4 (1 in. to ⅝ in.) No covering material shall be applied just after the first coat of bituminous material. If the aggregate is No. 2 size or coarser a small amount of covering may be applied just preceding the second application of bitumen.

The amount of No. 4 covering required will depend upon the size and hardness of aggregate that has been used. It may range from one cubic yard to 150 sq. yd. of surface where No. 3 aggregate has been used, up to 1 cu. yd. per 100 sq. yd. of surface where No. 2 aggregate has been used.



Sweeping No. 4 Covering Stone into Voids Before Third Coat of Bitumen

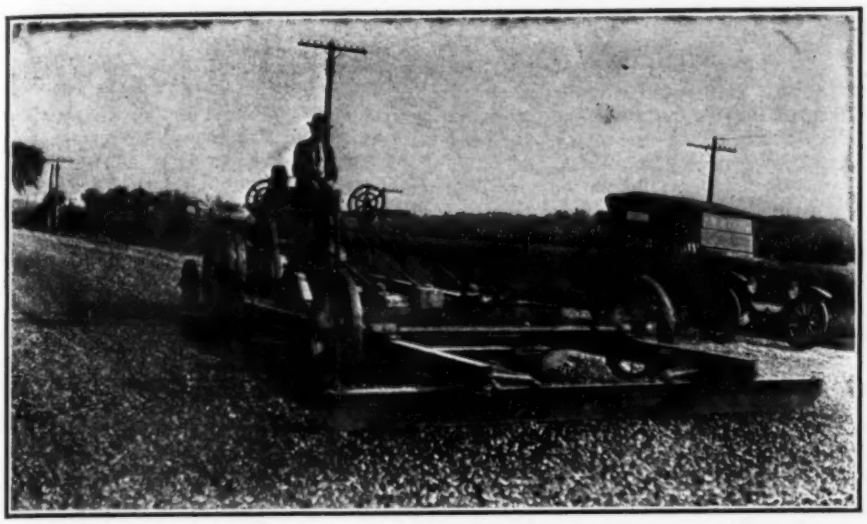
5. **Spreading of Coarse Aggregate, for Retread Top.**—The road shall be coated with 1 in. to 3 in. of No. 2 (1½ in. to 2½ in.) or No. 3 (1¾ in. to ⅞ in.) grade A crushed stone, slag or gravel. This loose aggregate may be spread direct from the trucks but shall be leveled with a road grader and maintainer so that it conforms to the proper crown and grade without any dips or irregularities. This loose material, if of size No. 2 and hard stone, shall be smoothed and compacted with a 10-ton 3-wheel roller just preceding the first application of bituminous material. If the aggregate consists of No. 3 size, this rolling before the first application of bituminous material may be omitted. If a comparatively soft aggregate is used, this rolling shall be omitted on the No. 3 aggregate and may be omitted on the No. 2.

6. **Applying the First Coat of Bituminous Material.**—To the aggregate uniformly spread as described above shall be applied the first coat of bituminous material. The aggregate may be rolled once while the bitumen is quite soft so that the max smoothing effect of the rolling will be secured. This coated aggregate shall then be permitted to cure until the bituminous material stiffens or becomes just sufficiently hard that it will not be unduly displaced by the rolling. (The curing period before extensive rolling will vary from a few minutes to several days, depending on grade of bitumen used and atmospheric temperature.) Any portion that has been disturbed by traffic or the distributor wheels to such an extent that the roller will not relevel same, shall be leveled either by hand or a road grader or maintainer just before rolling. As soon as the bituminous material is sufficiently hardened that the stone will compact well and remain so under the rolling, it shall be thoroughly rolled with a 10-ton 3-wheel roller. The wheels of the roller shall be sprinkled with water during the rolling, sufficiently to prevent the bituminous material from adhering to same. This provision shall be carried out in all successive rollings. This rolling can not be completed at one time but must be extended over several days in order that the aggregate will assume a proper position and remain bonded in place after the rolling is completed. The bulk of the rolling shall be done when the bitumen is sticky and stiff enough to hold the stone in place but not sufficiently dried as to become hard and brittle.

7. **Applying the Second Coat of Bituminous Material.**—After the first coat of bituminous material has sufficiently hardened so as to prevent the aggregate from being greatly disturbed by the roller or distributor wheels, and the surface has been thoroughly rolled, the second application of bituminous material shall be made. After this application, and when the bitumen is in the proper curing stage, the rolling shall be continued in sufficient amount to thoroughly compact the aggregate and eliminate all irregularities and depressions. Any depressions and irregularities which can not be eliminated by rolling shall be removed by the addition of aggregate of the same size as used in the top course and which has been previously coated with asphalt or tar. This rolling and leveling process shall continue until a true and uniform surface results and the bituminous material has sufficiently hardened so that the surface will resist longer being distorted by the roller or distributor wheels. The time of this curing process and rolling will vary from one day to five days, depending upon the grade of bituminous material used, and the temperature at the time the work is being done.

After the surface has become solid and just preceding the application of the third coat of bituminous material, the voids in the surface shall be uniformly filled with loose No. 4 grade A covering. **No rolling or traffic shall be permitted on this** loose covering before the third application of bituminous material. (These voids can best be filled by uniformly spreading same on the surface and sweeping them by hand brooms or with a broom dragged behind a light truck or car.) If an extremely hard stone is used for covering and the coarse aggregate shows very open voids, part of this covering may be applied just after the second application and before the rolling is completed. However, care shall be taken not to close up the voids too early as the bitumen down in the mixture must have time to harden before closing the surface voids; also any excess of covering and bitumen may be the source of waving and rolling later on.

8. **Applying the Third Coat of Bituminous Material.**—After the voids have been filled with loose No. 4 aggregate as described above, the third application of bituminous material shall be made. After the third coat of bituminous material has been applied, it shall be covered with additional No. 4 aggregate, after which the surface shall be thoroughly dragged with a long base metal blade drag or planer. The surface shall then be again thoroughly rolled, after which it can be opened to traffic. If under traffic the surface does not sufficiently close up to eliminate danger of raveling, another coat of bituminous materia. and No. 4 covering may



Dragging Retread Surface After Final Coat of Bitumen Has Been Applied

be added, preferably just before the road goes into the winter season.

The greatest precaution that must be taken with this type of work is to avoid building up a rich mat of bituminous material and fine covering. For this reason no sand or limestone dust or fine aggregate finer than No. 4 should be used in building up the surface. Any material amount of dirt, dust, sand or other fine aggregate with the bitumen is very likely to produce a soft mushy mixture which sooner or later will wave and roll under heavy traffic. **For this reason it is always best to be conservative on the amount of bituminous material used, keeping in mind that a little additional material can be added at any time, while if too much is applied, it is impossible to remove the excess.** Difficulty from a slight excess of bitumen can be partially corrected by the addition from time to time of hard No. 4 or coarser covering permitting traffic or the roller to force same into the soft mushy surface. While this is a partial corrective remedy for the excess bitumen, **it is always best to avoid in the first instance** the condition which will cause the waving and rolling of the surface. On heavily traveled roads there is more danger of using an excess of bitumen than on roads with light traffic.

9. Amounts of Bituminous and Covering Materials Required for Different Amounts of Coarse Aggregate.

If the coarse aggregate should have much fine material in it, which is very undesirable, the first coat of bituminous material should consist of Asphalt ACG, or Tar TC or TCM. Tar TCM may be used at any time instead of TM and it has the advantage of hardening quickly and will permit as early a completion of work in hot weather as CB. There is no value of the TCM over the TM or TH in cool weather. The No. 4 covering should be largely used just before the third coat of bitumen, the object being to fill the voids in the surface with coated No. 4 aggregate by the dragging process.

Methods of Maintaining Retread Top.—The standard method of maintenance of this type of surface is with retreatments every year or two.

The ills and ailments of this type of surface might be classified as (1) Waving and rolling under traffic, largely due to excess bitumen and which is accelerated by fine material; (2) Breaking and disintergration of the crust, thus forming "pot" holes or a raveled surface; (3) Failure of the base which results in a rough surface under heavy traffic and eventually a breaking of the surface.

The first defect, namely, waving and rolling, can best be corrected when it becomes excessive, by scarifying that portion of the surface which is defective, thoroughly breaking up the bituminous crust and adding to it a small amount of uncoated aggregate from the base, or by the addition of new aggregate to the top. This new aggregate should be thoroughly mixed with the old mixture by harrowing. After this broken up material is thoroughly mixed it is leveled off and again rolled in place and traffic permitted to immediately go over same. If there develops symptoms of disintegration of the re-formed surface a very light application of bitumen usually not exceeding 0.1 gal. per square yard may be added to prevent surface disintegration. Some repairs of this nature have been made which seem to carry quite heavy traffic for many months without again waving or rolling. The breaking up of the old bituminous surface and adding of new aggregate either from below or above, not only dilutes the mixture that is too rich in bitumen but also permits a ventilation of the bituminous material during which the volatile matters pass off thus hardening the bitumen and reducing the tendency to wave and roll. Isolated wrinkles or rolls may be corrected by hand picking and tamping the mixture back in place after the method described above.

The second defect, namely, breaking and disintegration of the crust, can frequently be prevented by applying a light surface treatment of tar or asphalt with the necessary covering material. Holes that have formed in the surface should be patched with one of the many patching mixtures; or, if only a shallow depression, with a "paint patch."

The third defect, namely, failure of the base, has but one remedy and that is to build up a thicker crust of metal. This may be done by building an additional retread top over the old one which is failing, after sufficient base metal has been added to secure the proper thickness.

Where Retread Top May Have Merit.—We should not expect too much from any road with a weak base. This type of surface should not be built on a road with very little base metal where heavy trucking is part of the traffic. The thickness of base required will depend upon the amount of heavy trucking that will come on the highway.

This type has merit in surfacing old stone and gravel roads which have a heavy course of metal on them or roads which carry a heavy automobile traffic only during the summer season.

With the proper conditions of base and traffic, the type has its chief merit in that a smooth riding dustless surface can be built at a very low cost compared with many types of pavement. The type is cheap in first cost because of the nature of the construction work which permits of dumping and spreading of stone direct from a truck and also which permits the stone to be leveled with a grader or maintainer before the bituminous material is applied. These cheaper mechanical operations reduce the hand labor to a minimum

Table I—Bituminous and Covering Material Required for Coarse Aggregate

Estimate Reference	Depth of Loose Aggregate	Size of Coarse Aggregate	Aggregate Required for Different Thicknesses (based on 2,500 Lbs. Per Cu. Yd.) Coarse: Tons Per Mile for 20 ft. Width	Coarse: Lbs. Per Sq. Yd.	Covering: Tons Per Mile for 20 ft. Width	Covering: Lbs. Per Sq. Yd.	Gallons and Grade of Bituminous Material Required Per Sq. Yd. of Surface: 1st Coat Gal.	1st Coat Kind	2nd Coat Gal.	2nd Coat Kind	3rd Coat Gal.	3rd Coat Kind	4th Coat Gal.	4th Coat Kind
A	3	No. 2 (2½ in. to 1½ in.)	1,222	208	200	34	.45	TM or CB CB or	.35	TH or CB CB or	.40	TH or CB CB or	.2	TM TH CB
B	2½	No. 2 (2½ in. to 1½ in.)	1,019	174	200	34	.40	TM CB or	.35	TH CB or	.35	TM CB or		
C	2	No. 2 (2½ in. to 1½ in.)	815	139	200	34	.35	TM TB or	.30	TH TH or		TM TM TH		
D	2	No. 3 (1½ in. to ¾ in.)	815	139	160	27	.30	CB TC TM AC	.25	CB TM or	.30	CB TM or		
E	1	No. 3 (1½ in. to ¾ in.)	407	69	145	25	.25	CB	.25	CB	.20	CB		

which by taking advantage of the old metal in the base, whether this be gravel, stone or some other material, are the principal things which contribute to the low cost of this type of road.

Someone has criticized the type because it is not as good as one of the more expensive types of road. The same argument might be used against a Ford automobile because it is not as good as a Lincoln. Granting the latter statement to be true, this is no argument why we should stop using Ford automobiles. A lot of people can have a Ford car that cannot afford a Lincoln. The same thing is true with cheaper types of road. Many people can have such a type that cannot afford the more expensive type. In buying a commodity, we must make the purchase fit the pocketbook.

However, we must not fool ourselves in thinking that a very thin crust of metal will carry heavy traffic in this climate where we have deep frost action and a rainy period which may come immediately after it thaws. **This type has its limitations and they must be recognized.** It would be more than wasteful to indiscriminately build it and thus place much of it where it is not appropriate.

Oklahoma Contractor Uses Finishing Machine for Asphalt Pavement

A substantial saving in labor was accomplished by the H. L. Cannady Co., of Tulsa, Okla., when they used their Lakewood Type "C" screed finishing machine for the spreading of asphalt surface.

This was a standard machine which had originally been used to screed and tamp the concrete base on which the asphalt top was to be placed. The tamper was not used for the asphalt, the screed member alone being employed to spread, compress, and surface the top.

The contractor reports that not only did he eliminate the necessity for expert hand rakers, and reduce materially the number of men required for spreading, but he also increased his daily production with the machine by more than 50 per cent over what he had been getting by hand work. He also obtained a smoother riding surface.

The machine travels on the concrete curb; no other side forms are required. The heat of the material keeps the steel screed member hot enough to prevent sticking when the machine is operating. In the morning, before starting work, the screed was given a preliminary heating with a kerosene torch. This was necessary on account of the fact that the temperature averaged around 34 degrees.

Highway Progress in Uruguay

Definite direction will be given to highway development in the Republic of Uruguay under the terms of a project of law organizing a National Highway Board, according to advices that have just been received at the Pan American Union, Washington, D. C., which is the headquarters of the Executive Committee of the Pan American Confederation for Highway Education.

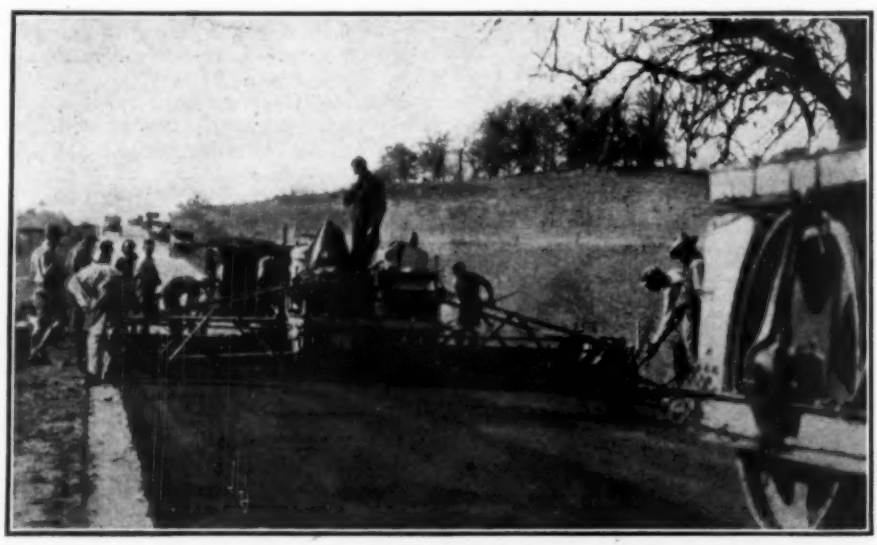
The National Highway Board will be created as a section of the Department of Public Works, and will have as its object the gradual improvement of secondary roads, the construction of highways, and all other matters relating to the extension of the highway system of the republic. To enable the board to carry out the purposes for which it is organized, the proposed law provides for an annual contribution of one millin pesos (the Uruguayan peso is equivalent to $1.03 U. S. gold) from the general revenues of the republic, and the proceeds of a number of additional sources, including an increased tax on automobiles and trucks, an increase in the import duty on automobiles, gasoline and lubricating oils, and in the tax on intangible property. The project of law has been submitted to the National Administrative Council and to the House of Representatives of the republic.

The project of law creating the National Highway Board was formulated by the Uruguayan Federation for Highway Education, which was organized in 1924 by a group of Uruguayan engineers who had visited the United States in that year and made a tour over some of the principal highways of this country as guests of the Highway Education Board of the United States. At the conclusion of this tour, which included representative engineers from all the republics of the American Continent, a Pan American Confederation for Highway Education was formed, with national sections in each country.

On the initiative of the Uruguayan Federation for Highway Education and the Automobile Club of Uruguay, a National Highway Congress was held in Montevideo in October, 1926. More than three hundred delegates were in attendance, representing virtually all the scientific and technical institutions of the republic, and it was there that the movement was inaugurated to create a national body to promote highway extension. The Uruguayan Federation for Highway Education appointed an executive committee, which formulated the project of law creating the National Highway Board.

At the present time the highways of Uruguay compare favorably with those of other countries. The topography of Uruguay is favorable for transportation development, the land for the most part being level or gently rolling. A well developed system of highways surrounds Montevideo and penetrates a considerable distance inland. The purpose of the proposed law is to extend this system and to connect all the principal cities of the republic.

Three Hundred and Seventy-five Miles of Michigan Highways Lighted.—Michigan's trunk line highways, which in a decade or so have advanced from gravel to pavement, are taking another step forward. They are becoming lighted paths, as safe for travel at midnight as at noon. Figures compiled by the General Electric Co. show that, with recent additions, the lighted rural highways now stretch a total of more than 375 miles in that state. The mileage is growing with increasing speed. The bulk of the present highway lighting is concentrated in the so-called Detroit area.



Finishing Machine Used on Asphalt Pavement Construction

Surface Treatments With Asphalt As Used In West Virginia

Methods of Treating and Repairing Standard Types of Macadam, Gravel and Shale Surfaces

By B. E. GRAY

Division Engineer, State Road Commission of West Virginia

A HIGHWAY system is analogous to a railroad system, in that it is purely a means of furnishing transportation service. The various lines of a railroad are improved according to the traffic which they are called upon to bear, and there is no reason why a highway should be improved on any other basis than that of making it adequate for the traffic which will come upon it. Accordingly, wherever it is possible to use local materials immediately available to the road side, and make surfaces which will give adequate service at a low cost, such a type certainly should be used rather than arbitrarily selecting some high type, purely for reasons of sentiment or because of public clamor.

Two Groups of Surface Treatments.—The subject of surface treatments may be well divided in two parts; under one, being included those treatments given to preserve the original surface (and which includes water bound macadam, puddle macadam, penetration macadam and other similar types of surface), and under the other, those surfaces to which treatments are given either as a dust palliative, or to improve and build up a better or higher type of surface.

The technique for the first group is pretty well established as a result of long year's experience. In the second grouping, however, there is a great field for development, improvement, and experimentation. I shall briefly run over the methods and materials used in handling the several types of surface treatments, with particular reference to specification of material. cost, traffic, and annual maintenance cost.

Treatment of Water Bound Macadam.—Water bound macadam is a type rather infrequently built today, but yet there is a large mileage of such roads in every state highway system in the country, which are giving excellent service results where bituminous treatments have been given. The first application consists of a light asphaltic material with a fairly high percentage of volatile elements which evaporate within a short time after application. We use a 55 to 65 per cent 100 penetration asphalt for the priming penetration with a cover coat of ⅜ by ⅝ in. chips. Two successive quarter gallon applications are better than a single ½ gal. application and about 10 lb. of chips are required as cover coat for each application. The following year a single ¼ to ⅜ gal. application will be required, with successive treatments about every three years, under medium traffic, using cold liquid asphalt.

Treatment of Penetration Macadam.—For penetration macadam, and similar types surface treatments should not be given until the surface shows pitted and the coarser stone begins to show exposed below the edges. I believe the mistake is often made of giving a surface treatment when all that is required is a little patching and the surface then carried over for another year. I recall some 15 years ago when in Massachusetts, and before the precision of asphalt manufacture was anything like today, I worked with a Charles Howes, Division Engineer, who used to say to us every winter when we brought in our recommendations for the following season's maintenance, "A good rule for the time to surface treat is to let the surface go until it looks like it would go to pieces if it wasn't treated immediately, and then let it go for another year." While we didn't always agree with him, largely on account of the appearance of the road surface, yet it is a fact that to hold a smooth surface, the minimum application that will hold chips is the proper amount. In West Virgina we have used two types of treatment on penetration, hot asphalt with 1¼ by ¾ in. chips and cold liquid asphalt with ⅝ by ⅜ in. chips. The specification for hot asphalt is as follows:

1. Flash Point, not less than	175 c.
2. Penetration at 25°c., 100 g., 5 sec.	150-200
3. Ductility at 25°c. not less than	30
4. Loss at 163°c., 5 hrs., not more than	3%
5. Penetration of residue at 25°c., not less than	90
6. Per cent of total bitumen soluble in Carbon Tetrachloride, not less than	99%

The specification for cold asphalt is as follows:

	Min.	Max.
1. Specific Gravity at 60° F.	0.9450	0.9650
2. Specific Viscosity Engler (1st 50cc. at 104° F.)	35	50
3. Evaporation Loss 20 grs. 5 hrs. at 212° F.	25%	
4. Flash Point (Open Cup)	95° F.	125
5. Evaporation Loss 20 grs. 5 hrs. at 325° F.	27%	35%
6. Penetration at 77° F. on Residue from Loss at	325° F. 40	75
7. Asphalt Contents at 100 Penetration	68%	
8. Bitumen Soluble in CS2	99.5%	
9. Per Cent of Total Bitumen Insoluble in 86° N.	15%	

In general hot treatment is used on sections through the mountains where the coarse chip gives a roughened surface which is non-skid, and which will remain in the roughened condition for several years, or else on sections where it is desirable to increase the thickness of the wearing course. Hot treatments, while they do not produce that superior smoother riding surface which is so attractive yet have a number of advantages. The material sets up almost immediately after application, and as soon as coarse chips are thrown on for cover, traffic can immediately use the road without picking up the chips or getting bituminous material on the car. Two successive hot treatments, however, are never given, as there is a tendency to produce a wavy surface with the additional application and as the hot material never sets up quite as hard as the cold application. Hot asphalt is applied at the rate of ¼ to ⅜ gal. per square yard and requires from 25 to 30 lb. of chips for cover coat.

Patching With Cold Asphalt Patch.—There may also be included in this first group of surface treatments, the item of patching, as it is pretty difficult to tell where patching leaves off and surface treatment begins. We have been using a cold asphalt patch during the past year which has been unusually satisfactory, in fact it is superior to any material that we have ever used. In view of the much lesser cost of making the poured patch and because of the very smooth surface that can be obtained, I can see no reason why the mixed patch should be considered for highway maintenance today. We are using this cold patch not only as a repair material but also as a method of widening narrow pavements (including concrete) and also for evening up rough pavements prior to initial surface treatment. The specification for this cold asphalt patch is as follows:

	Min.	Max.
Specific Gravity	0.9350	0.9500
Specific Viscosity Engler (1st 50c.c. at 122° F.	25	40
Evaporation loss 20 grs. 5 hrs. at 212° F.	24%	
Penetration of 77° F. on Residue from loss at 212° F.		125
Evaporation loss 50 grs. 5 hrs. at 325° F.		30%
Penetration at 77° F. on Residue from loss at 325° F.		115%
Asphalt contents 100 penetration	70%	
Bitumen soluble in CS2	99.5%	
Per cent of total bitumen insoluble in 86° n	18%	

While the general policy in West Virginia is to grade a road a year or two in advance of paving, this has not always proven practicable, and on roads where paving has been carried on sim-

Table 1—Showing Asphalt Treatment Costs

Type	Cost of Initial Surface Treatment Per Square Yard	Period Between Treatments	Annual Maintenance Per Sq. Yd. Including Patching	Traffic Number Vehicles
Water Bound Macadam	$0.09	1 yr. to second	$0.04	500 to
Puddle Macadam	½ gal.	3 thereafter		1000
Penetration Macadam	$0.05 cold; hot, $0.08-.10	1 yr. to second	$0.03	500 to
Cold Patch and Widening	¼ gal.	3 thereafter		2000
Gravel	$6.00 per ton complete in place including everything. Requires 6 gal. per ton with 1¼ chips plus 3 gal. per ton with ⅝ chips to seal. Total 9 gal.	3 years	$0.03	500 to 2000
Shale	$0.11 cold $0.10-$0.15 ¾ gal.	Average every two years	$0.10	200 to 800
	$0.05 cold ½ gal.	Annual	$0.06	300 to 800

ultaneously with the grading, some settlements have occurred on the heavy fills or in low swampy sections, which in places has resulted in a wavy and uneven surface. Prior to the first surface treatment of such surfaces, cold patching is carried on, using a straight edge, and continuing such patching until no further settlement occurs. Edge patching is concurrently carried on, widening all points where traffic tends to ride the shoulders. As fast as these patches pound down and settle, additional material is added until stability is obtained. By such edge patching, about a foot additional width of pavement is gained at each treatment. When the next surface treatment is made, the whole blends in together, and a smooth riding and also a good looking surface is obtained.

Surface Treatment Intervals. — The most essential characteristic of any road is smoothness, as this is the criterion of the public for quality. With continued smoothness thereof necessity is stability, and with a smooth surface there should be no need for surface treatments more often than every three years, except under very heavy traffic, and with hot treatments even four years have elapsed between applications. As a general practice, however, and since cold asphalts have reached their present stage of accurate development, we favor their use, with light treatment not to exceed ¼ gal. per square yard about every three years. In some cases ⅛ to ⅜ gal. every two years may be desirable. Cold asphalts have a greater stability after set-up and when applied at a rate just sufficient to hold chips, resist shoving and waving of the surface.

Surface Treatment of Gravel Roads. —So much for surface treatments and repair of standard macadam type of construction. It is in the second grouping that I am particularly interested, and wherein I believe the greatest amount of development may yet be carried on.

Gravels vary widely in grading and character and the satisfactory rate of application has to be worked out for each particular character of gravel.

The general procedure is to allow the gravel to become well compacted under traffic, frequently blading the surface and adding new material until smooth and even. As soon as the surface has fairly well dried out in the spring, about the latter part of May or early June, it is lightly swept with a rotary sweeper and a quarter gallon application of 60 per cent 100 penetration asphalt applied with the distributor. The specification is as follows:

	Min.	Max.
1. Specific Gravity at 60° F.	0.950	0.970
2. Flash (Open Cup)	175° F.	
3. Asphalt contents at 100 penetration	58°	66%
4. Evaporation loss 50 grs. 5 hrs. at 325° F.		12%
5. Engler specific viscosity at 122° F.		80
6. Bitumen Soluble in CS2	99.5%	
7. Bitumen Insol. in 86° Naptha	140%	

No cover coat is put on this first application and it is nearly all absorbed by the road surface. Several days later a second ¼ gal. application is made and covered with ⅝ in. pea gravel or chips. With fine gravels, this second application will usually be about enough for the first season. If it absorbs pretty well, however, or is pitted, a third ¼ gal. application is applied and again covered, and in some cases even the fourth ¼ gal. application is made, and covered before a smooth uniform surface is obtained. This gradual building-up process is desirable, because there is no way of predetermining just how much asphalt will be absorbed by the surface as is the case with a macadam surface. These light applications should be added until the desired appearance of the surface is obtained, whether it is ½ gal., ¾ or even a gallon, and no definite rule can be laid down. I wish to repeat that in my opinion practically all failures in surface treatment of gravel have been due to inadequate amounts of bitumen, or else where there is an insufficient thickness of gravel to produce stability of surface. We have treated all kinds of gravel roads from the extremely fine chert gravel up to the very coarse creek gravels, and with uniform success.

Surface Treatment of Shales.—Nearly every section of the country has a local material which has given success as a road surface material in one form or another. The particular material easily available in West Virginia is shale. There are, however, an infinite variety of shales, some absolutely worthless as surfacing materials, while others produce an appearance very similar to first class water bound macadam. An interesting development in the use of shale has been the making use of previously gained knowledge, to predetermine whether a proposed material will give satisfaction, and even information as to where to look for such material.

From time to time as shale has been used as a surfacing chemical analyses have been made of each pit and at a later date comparisons made with service results so that a fair index of the worth of material is now possible from a knowledge of its chemical make-up.

In general a shale must contain from 50 to 70 per cent silica, from 4 to 10 per cent ferrous oxide and from 5 to 10 per cent magnesium and calcium to be a thoroughly stable material. If the clay content runs much over 20 per cent the material will break up badly during the winter. While these shales vary widely in their chemical analysis, yet the same kind of shale is usually found within the same geological horizon. As you know, a geological horizon is entirely separate from elevation and bears no relation thereto.

Knowing, therefore, that a certain good shale can be obtained in a certain strata and by reference to a good geological map of any area, it can be predetermined fairly closely where to look for such material. By following out this practice, it has been possible to build some very excellent graded shale roads at low cost which are giving first class service.

These roads are good summer and winter, but under fast moving traffic become dusty during the dry season and somewhat slippery during rainy weather. To overcome this, surface treatments have been given, and in some cases have progressed beyond the surface treatment stage to the building up of thin macadam wearing coats.

The first application is a cold asphaltic material which should not much exceed 60 per cent 100 penetration asphalt. In May or early June the surface is lightly swept with a rotary sweeper and the cold material applied at the rate of about ¼ gal. per square yard.

With high grade shales there is practically no absorption of the asphaltic material (as is found with gravel) for the shale is very dense. Accordingly, it is necessary to apply cover to the first application, and this is done by carrying back the windrow of self material that was swept off the road first. This is done with a one-man grader.

Places not covered with the grader are touched up by hand, taking additional cover coat from the edge of the road itself.

Several days after the first application a second ¼ gal. application is made, which as a general rule fills all open places left by the first application and produces a thin bituminous mat uniformly over the entire surface of the road. One-half gallon is usually a sufficient amount for the first season's treatment.

Roads so treated are extraordinarily

smooth and easy riding and far superior in such qualities over any other type of pavement. During the first winter, especially if there is much freezing and thawing, a considerable portion of the surface may break up and flake away, usually at those sections of the road where poor quality material had been used or where drainage conditions had not been entirely corrected, rarely, however exceeding 20 per cent of the total mileage. With the next season's treatment there is a certain carry over so that on long stretches only ¼ gal. application is necessary to reproduce a smooth and uniform surface, but as a rule it is better to plan for an entirely new treatment.

The great advantage of this method, is the rapidity with which it can be carried on. The item of cover coat is almost eliminated, which in macadam surface treatments usually makes up one-half the cost of the work. These asphalt treated shale roads have given entire satisfaction and over a large mileage are giving all the transportation service that could be obtained from the very highest type of construction. These roads have carried as high as 1,000 vehicles per day, but average from 300 to 800 summer traffic, 200 to 400 winter. Sometimes during the latter part of the season there will be places that will ravel and it is desirable to go over the surface with a patching crew, touching up such ravelled places by merely sprinkling on the cold asphalt and covering with a shovel full of shale from the side of the road. It is interesting to note the cost of such patching work on one 9-mile section where two men with one Ford truck and 600 gal. of asphalt completely patched the section in five days' time, at an average cost of $11 per mile.

Work of this kind is a direct challenge to the highway engineer of today. It is no particular trick to build a $50,000.00 per mile road where all materials are available of the best; it simply requires attention to details in carrying out the specifications to produce a satisfactory road, but where funds are limited, where the need is great, and where a satisfactory road can be produced for $3,000, or $4,000 or $5,000 per mile which gives entire satisfaction to the traveling public, then I believe the engineer performs a real service.

Acknowledgment.—The foregoing is taken from a paper presented at the 6th annual Asphalt Paving Conference, Atlanta, Ga., Nov. 28-Dec. 2, 1927.

Pavement Rater

With a clause in the Illinois specifications for portland cement concrete pavement providing for a surface which shall not deviate more than ¼ in. from the true surface as determined by a 10 ft. straight-edge, it becomes essential to develop an instrument for testing pavement smoothness which shall combine efficiency of operation and accuracy of measurement.

Several years ago such an instrument was developed in District No. 4 of the Illinois Division of Highways which after five years of use has proven itself so satisfactory that at the beginning of the 1927 construction season there were nine in use.

The device, which is called a pavement rater, consists of a wooden frame made up of two parallel members to which cast-iron end wheels are attached. The indicator, carrying a heat-treated steel roller is swung from the frame at its middle point. Attached to the indicator are steel scrapers, one of which is in front of and the other behind the roller.

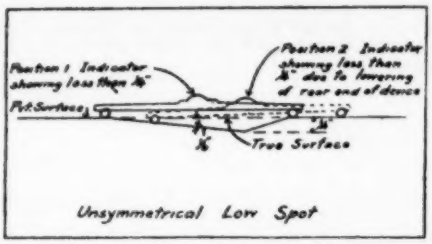
This instrument was designed and built to give quite accurate results. The end wheels were turned on a lathe within two-thousandths of an inch of true. Adjustable babbited bearings were used to take up any wear that might occur. The rollers on the indicators were made of such material that there would be no appreciable wear due to being used on hard surfaces.

The adjustment of the pavement rater is made by shifting the entire indicator up or down in the frame, and by changing the position of the scrapers. A fine thread stretched along the bottom of the wheels furnishes the basis for the measurements.

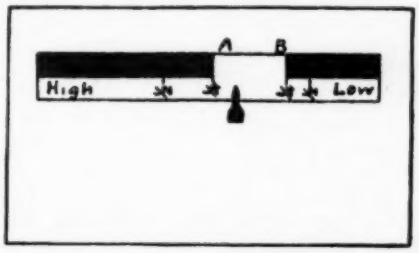
The instrument is positive in the detection of irregularities. There are no near high or low spots. If the scraper comes in contact with the surface of the pavement, the point of contact is either high or low, as the scraper indicates.

From the illustration, it can be seen that the scrapers are placed on each side of the small roller. From the position in which the roller is attached to the frame, one scraper indicates the depressions, and the other scraper the high places. These are shown on the graduated dial above the roller by a pointer.

Straight-edging is done by pushing the instrument over the pavement. The pointer standing on the long central mark, (see drawing) indicates true surface. The pointer oscillating between marks "A" and "B" indicates waves three-sixteenths of an inch from true surface. When the pointer moves into the black areas, an irregularity of more than one-quarter of an inch has been encountered. The detection of ¼ in. variations is made more positive by the scrapers dragging and producing the scraping noise, or in case of green concrete, by marking the surface. The instrument also shows the dimensions of the irregularity from a true surface.


Position 1 Indicator showing less than ¼"
Position 2 Indicator showing less than ¼" due to lowering of rear end of device
Pvt. Surface
¼"
True Surface
Unsymmetrical Low Spot

Sketch Showing How Pavement Rater Is Used

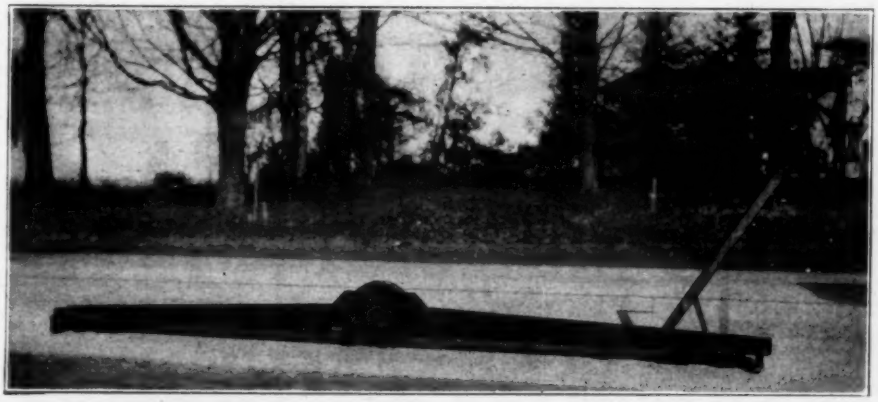


Markings on Dial

Pavement Raters having three indicators spaced 2½ ft. apart, have been used. This is to conform with the theory that unsymmetrical high and low places exist on the pavement surface which only a three indicator instrument could detect.

After using several instruments of this design for two years, it was found that 99 per cent of the variations were detected by the middle indicator, and for this reason, the other two indicators have been eliminated from this machine.

This machine was developed by Harold Andrew, Assistant Engineer, Division of Highways, District No. 4, and its cost is approximately $40.00.



Pavement Rater Developed in District No. 4 of the Illinois Division of Highways

Experiences of Minnesota in Maintenance of Secondary Type Roads

Concise Sumary of Highway Maintenance Methods Given in Paper at Purdue Road School

By W. F. ROSENWALD
Maintenance Engineer, Minnesota Department of Highways

IF we could be assured that the volume and nature of traffic on our roads would not change, the problem of maintaining them would be very much simpler than it now is. It would be comparatively easy to work out efficient methods with satisfactory equipment, and when once organized one could sit back and see the work go on without further worries. Instead of having such a condition we are confronted with an ever increasing volume and weight of traffic, and in addition to this the users of the highways are becoming ever more insistent on greater comfort and better service. The result is that the maintenance of roads is an ever changing problem requiring new methods and new operations as the traffic demand increases. This constant change and its effect is much more evident on the secondary or cheaper type of roads which are surfaced with stone, gravel, sand, clay, etc., than on the higher type paved roads. Usually the capacity of the secondary type road is constantly being taxed to the limit which necessitates the working out of some relief which will serve until a higher type of road can be constructed. This condition is in many instances successfully met with a systematized progressive improvement or development with occasional results which ultimately approach the serviceability of the higher types.

After all, the real purpose of all our operations is to provide the public with a serviceable road, and with the constantly changing traffic, it is self-evident that the nature of the road must be changed either by gradual betterment as the traffic increases or abruptly by construction when the road will no longer carry the traffic. Apparently the most certain feature in our work is that the traffic will increase constantly.

The Problem in Minnesota.—The maintenance problem in Minnesota involves the upkeep of a 7,000 mile state maintained road system of which 5,500 miles are gravel surfaced, and a 12,000 mile county maintained state aid system of which 9,000 miles are gravel surfaced also.

To help us in meeting the constantly changing problem we have systematically taken a large number of traffic counts on the state maintained system during the past seven years, and these indicate that our average rate of increase in volume of traffic is somewhere between 20 and 25 per cent per year. The counts are ordinarily taken at points between the various cities and villages so as to avoid the purely urban traffic. The average daily traffic on the state maintained system now is 940 vehicles per day, ranging from 144 as the low, to 6,895 as the average daily traffic on our heaviest traveled road, and with single days above 15,000. The average traffic on our pavements is about 2,103 vehicles per day, and on our bituminous treated roads the average is 1,274 per day. From a rather careful analysis we have arrived at a figure of 580 per day as the economic limit of traffic on our untreated gravel roads, but we are actually carrying an average of 630.

We have gone through the experience with the wheelbarrow patrol, the team patrol, the gang patrol, and with the tractor and trucks patrols. The man and wheelbarrow patrol passed out of the picture with the horse-drawn, steel-tired traffic, and with the increasing wages.

The Team Patrol.—Up to a certain point, probably an average daily traffic of about 300 vehicles, the team patrol is undoubtedly the most practical, as this is the one and only all-purpose maintenance unit which is able to perform all necessary operations without supplementary help. This unit is most efficient on sections not over six miles in length.

The team patrol must be equipped with a wagon for hauling material, slip scraper and hand tools for cleaning drainage lines, mower and scythe for cutting brush and vegetation, and a blade grader or machine for smoothing the road surface. Originally the team patrols were equipped with drags of the split log type. These soon developed into planers of various designs and then into light graders. The weight of the graders however, has increased with the increase in traffic.

The team patrol may not be the most economical in each particular operation. For instance it is entirely possible for a power patrol if operated continuously to do the smoothing at a less cost or for a gang to cut the weeds for less money, and so on, but to perform each operation in such manner would mean a much more elaborate organization with consequent additional expense; therefore as the team patrol itself can do all the different kinds of work required, it is the most economical unit up to the limit of its capacity. Probably one of the most wasteful features of the team patrol is the time lost in going to and from work and in making necessary periodic trips over the section.

As the volume of traffic increases it develops that the team patrol on certain roads is not able to keep up its work and it becomes necessary to supplement it with tractors, tractor patrols, or trucks and in some cases with special work gangs or crews. As the volume and speed of traffic increases, it also becomes more hazardous for the team patrol which naturally makes it more difficult for it to work efficiently. The point has been reached in many cases where the team patrol should be discontinued entirely, but we have been reluctant in making the changes too suddenly, partly out of consideration for the patrolmen but more particularly because of the rapid developments which were taking place in equipment. We have avoided the purchase of large quantities of any one type of equipment at any one time with the result that we are able to take on the newer developments without suddenly finding that we have on hand a large amount of obsolete equipment which has not been fully charged off.

Truck Patrols.—It is now evident, however, that we will have to discontinue our team patrols at a much faster rate, and our present tendency is to replace them with truck patrols, and a crew of two men, covering from 20 to 25 miles. Our tendency towards trucks is at least partly due to the facility with which they can be adapted to snow fighting operations in winter. On account of our snow work and also because they will have to pull graders in smoothing work, the trucks should principally be of 2½ to 3 ton capacity with heavy duty motors. They should be on pneumatic tires and capable of operating economically at both a low speed and also a high speed of about 25 miles per hour. The grader should be of about 5,000 lb. weight with a 10 ft. to 12 ft. blade and mounted on rubber tired wheels with roller bearings. A spring blade under the truck is very useful but will not take the place of the blade machine. The dump body on the truck should be equipped with power hoist and should be rather wide in order

to be as low as possible to make the loading easier by hand shoveling. It pays to make the work easy for the men.

This kind of a unit will serve equally well on the higher type paved roads as on the secondary types and consequently does not have the objections that it may be necessary to make a radical change as the traffic or type of road changes. It will of course be necessary in some cases to supplement the truck patrol with special gangs or equipment to perform special work. A tractor or power patrol machine will be very useful at times and a limited number should be available to supplement the work of the truck patrols when they are too busy hauling material. A scarifier is also a necessity on any secondary type road, and although in some cases a scarifier attachment on the grader pulled by the truck will serve, it will generally be found to require a tractor for pulling power. On gravel roads the combination grader and scarifier is generally found the most practical.

Replacing Surfacing Material. — A certain amount of the surfacing material on the road is always being thrown off or worn out by traffic and blown away, and it must be replaced. This probably approximates from ¼ to ½ cu. yd. per average daily vehicle per mile. Except on light traffic roads the patrol is not able to fully replace this loss, without help, and it is economical to supplement the patrol work at intervals of two or three years with a truck fleet which can naturally be organized to deliver gravel for less cost than can the single patrol unit.

Regraveling work should be handled in the same manner as new construction. The best practice is to deposit the new material in windrows either at one side or in the center of the road and to immediately spread it out with a blade machine blading it entirely across the road and windrowing on the opposite side of the road all except a thin floating surface. This operation mixes the material thoroughly and gives a uniform product to work with. The material in this windrow is then gradually fed onto the road surface with the smoothing machines and as fast as the traffic will warrant. This makes it easier to maintain the thin film of floating material on the road which is so essential in holding a satisfactory surface. In order to keep this thin film in place, it is necessary to blade it very frequently and as the volume of traffic increases the more frequent must be the blading. This method of applying surfacing material also makes for greater safety to the traffic by avoiding the dangers of accidents caused by fast moving vehicles suddenly striking deep and loose material. On new construction our general practice is to place 1,200 to 1,400 cu. yd. per mile in windrows and about 400 cu. yd. in stock piles. On regraveling operations we ordinarily place about 400 to 600 cu. yd. per mile, a part of which goes into stock pile. Our patrol units place on an average of about 100 cu. yd. per mile per year principally from the stock piles which are placed at convenient intervals, usually not over a mile apart. With the truck units the stock piles can be placed at greater intervals and more material hauled from pits.

In this connection, chatter bumps or rhythmic corrugations are usually mentioned. We do not consider them as anything serious but merely as an indication that the blading has not been frequent enough or severe enough, or that the equipment used is too light or weak.

Flat Crown Maintenance.—From the standpoint of safety to traffic, and further to avoid concentrated travel in one track, we endeavor to maintain as flat a crown as possible. We prefer not to exceed a 6 in. crown in 30 ft. width of roadway. Too coarse a size of stone or pebbles and an excess of fine sand must be avoided. All surfacing material should be screened. Our practice is to use a screen with openings ¾ in. square, or 1 in. round. Gravel or stone well graded from 1 in. down to sand is of course the ideal material but as a rule we do not have much choice and are compelled to use material which may be available in the locality. Where the natural material does not have enough binding material it is usually comparatively easy to add clay or other similar binder.

Relieving Dust Nuisance.—As the volume of traffic increases, the trouble with dust increases. The trouble is not only the loss of material but it soon becomes a serious hazard to the traffic on the road. The safety of the traffic alone would probably justify steps to relieve the dust nuisance, but with an average daily traffic of over 500 vehicles it is usually found that the saving alone of surfacing material will pay for special treatments.

Calcium chloride treatments are a great help on sandy and very dusty surfaces, and it is our policy to use it especially on roads which are soon to go under construction paving operations.

On roads where the traffic is too much for the untreated gravel and where the possibilities of paving are too far distant in the future, we are now rapidly extending bituminous treatments of both tar and oil.

Bituminous Treatments.—We started to experiment with bituminous treatments on gravel roads in 1924. The experimental work has continued since, and we are now getting good results from both tar and road oil on roads which were originally not considered suitable for such treatment. At the present time 387 miles of bituminous treated roads are being used to the satisfaction of the traveling public and definite methods of treatment have been established. The experimental work has not been dropped after the initial treatment but carried on further in the lines of maintenance and construction.

Tar and cut back asphaltic oils have been pretty well established for gravel roads and practice common to other states is used with a few variations. Very little can be added on this subject that others have not used. However, some methods now in practice in Minnesota have been frowned on by practitioners of the older states. It must be remembered that conditions in this state are far different from those in states where roads and highways have been built and rebuilt covering a long period of years. Gravel roads in this state consist of a thin crust of gravel and clay and not a consolidated or waterbound macadam of 6 in. to 2 ft. in thickness. Therefore practice common to us necessarily has to conform to existing conditions.

Method of Applying Bituminous Treatment.—Our method of application is as follows: The roadway is first bladed smooth and true to cross-section using either a heavy tractor and a 12-ft. blade or a rather heavy motor driven patrol grader. The former is preferable as a smoother surface is obtained. The loose gravel and cover material is windrowed then along the shoulder of the road. The roadway is not swept in most cases but the bituminous material is applied directly on the grade as bladed.

Half of the roadway is treated at one time to afford room to carry the traffic at minimum inconvenience. An 8 ft. width of oil or tar immediately next to the windrow of gravel is applied at the rate of 0.3 to 0.5 gal. per square yard. One to two miles of roadway is covered in this manner. A power patrol precedes the distributor to blade off as much of the loose material as possible. The prime coat is applied at a temperature of 135 deg. to 150 deg. F. Then a 4 to 8 ft. width is applied adjacent to this strip, depending on the width of roadway to be treated. This side of the road is allowed to set as the tar or oil penetrates into the road bed. This takes from one to ten hours.

Then the second half of the road is treated in a similar manner and traffic carried on the side with the prime coat. The tar or oil does not pick up, but the weak spots are brought out and can be patched before the seal coat is applied.

When the second side has "set" sufficiently to handle traffic without picking up, the process of applying the second or seal coat is in order. Again starting next to the windrow of gravel an 8 ft. width is applied at the rate of 0.3 gal. per square yard. This is applied at a temperature of 125 deg. F. A power patrol equipped with rubber tires immediately pulls the gravel over this application, spreading the material about 1 to 1½ in. deep. The seal coat is applied over the entire surface and as soon as the gravel has been spread the

roadway is ready to carry traffic without picking up.

Traffic then does the work of binding the metal into the road but a smoothing machine, preferably a power patrol or blade grader, goes over the road continually for three or four days to insure a smooth riding surface.

As soon as the tar or cut back oil "sets up," blading is discontinued but any weak spots which develop are immediately patched with premixed material using the same kind of tar or oil and gravel as that used in the treatment. This maintenance when done consistently and conscientiously will give a good riding quality to the road.

If waviness develops after the tar or oil has set up, the corrugations can be removed by cutting the ridges with a large blade. This operation should be performed on a hot day and the blade set to secure a shaving action.

Cost of Bituminous Treatment.—A road thus improved costs about $1,500 to $1,800 per mile the first year. The second year the cost is about half that amount and in a good many cases the third year does not require any treatment.

It has also been demonstrated that a road treated in this manner can be scarified and reshaped with very little cost and with very beneficial results. One patrol unit can easily patch and maintain twenty miles of road improved in this manner, providing the traffic is not much over 1,000 vehicles per day.

Experiments With Gumbo and Clay.—In 1925 due to the evidence of diminishing supply of gravel and also the inherent characteristic of certain subsoils to "eat up" gravel, experiments on gumbo and clay were tried, hoping to waterproof the grade in order to hold the gravel up and the water out. It was hoped that gravel consumption could be reduced and the road made more serviceable during all seasons of the year. Especially in the gumbo during the spring and fall, the roads, even with 1,600 yd. of gravel, are almost impassable. The rains and spring "break-ups" render these roads as muddy, sticky, and rutted thoroughfares requiring an unlimited expenditure of funds to get traffic through. Oftentimes these mud holes or "frost boils" have to be planked to accommodate the traveling public.

The first attempt toward the solution of this problem was the use of a road oil applied in two applications of about 0.3 gal. per square yard. This oil was not covered with gravel and difficulties were encountered which discounted the method but the mere fact that the oil did waterproof the road and did stiffen or toughen the crust encouraged the Department to go further. The outstanding difficulties of the foregoing process was the inability of preventing the "picking up" of the oil, especially by steel tired vehicles. These roads are in rural communities where the latter class of vehicles are numerous. Then the surface of a road which is oiled and not covered with gravel develops a slippery surface which introduces a hazard especially in wet weather. The cost of patching and maintenance is higher on this type of surface and scarifying has to be done more frequently which again requires more oil.

At the same time that the above experiment was being carried on, several other experiments on clay and gumbo were tried using varying amounts of oil and gravel for covering material. Results were encouraging and the following year oiling subgrades on a large scale was started.

Method of Oiling Subgrades.—Our method of subgrade treatment is as follows: The newly graded roadway to be treated is first allowed to take traffic for some time thereby bringing out the weak spots in the road. These defective areas, sags or pockets of ununiform material, are filled with the prevailing clay or gumbo, and the roadway is then subjected to concentrated blading or planing to develop a very smooth surface. The inherent ability of this class of soil to pack and harden soon has the roadway in a uniform, smooth, and fast surface. While this operation is in progress, gravel is windrowed along one shoulder of the road at a rate of 350 to 450 yd. to the mile, ready to be bladed over when the oil is applied.

When the road is shaped and dry (the latter cannot be emphasized too strongly) the application of oil is started.

Half of the roadway is treated first with a prime coat of as much oil as the material will absorb. This usually is between 0.35 and 0.55 gal. per square yard. It is applied with a power distributor at a temperature of 175 deg. to 200 deg. F. When this oil has driven in so that it will not pick up, traffic is allowed to use this side of the road and the prime coat applied on the other.

After the entire roadway has received the prime coat and is dry, a seal coat is applied starting on the side of the road first primed, which is also the side on which the gravel is windrowed. The application of the seal coat can be at a lower temperature, about 160 deg. F., and at the rate of 0.3 to 0.35 gal. per square yard. As soon as the seal coat is applied or within half an hour afterward a power patrol equipped with rubber tires and a 12 ft. blade pulls the gravel over the oiled surface. The entire surface is covered in this manner and the roadway is then ready to carry traffic inconveniencing no one and benefiting the treatment.

A thin layer of gravel is kept floating over this treatment and with the exception of a slight discoloration exhibits all the characteristics of an untreated good gravel road.

Maintenance on this type of road consisting of blading and planing is started at once and carried on consistently. In some cases power patrols are used, but in most cases spring blades mounted on trucks are found very satisfactory on these roads.

During the second year the roadway is bladed free from loose material and a light application of the same kind of oil used the first year is applied at the rate of 0.2 to 0.3 gal. per square yard. This is again covered with a thin coat of gravel. About 125 to 150 yd. to the mile of additional gravel will serve for this cover coat.

In places where break-ups have occurred or where extreme roughness is in evidence a light scarifying will remedy the difficulty with little additional cost.

The cost of this treatment ranges between $1,200 and $1,800 per mile the first year and half that amount the second year. In some cases the third year can go without any treatment, but it is usually advisable to repeat the second year treatment.

In connection with the maintenance of secondary type roads it is well to give careful consideration to the bridge and other structures. A mistake very easy to make is to renew or replace a structure with one of a permanent nature which in a few years will not handle the traffic or which will be found to be in the wrong position a few years later when it may become necessary to improve the location and alignment of the road in order to increase the traffic capacity of the road. Making it possible for the traffic to move at higher speeds safely is undoubtedly one of the most economical methods of increasing the traffic capacity of a road.

At times we show a tendency to attempt so-called permanent construction before either we, or the public generally, is ready for it, with the result that we at times have a badly laid out road of a permanent nature which in the end will prove most uneconomical.

The secondary type roads must take up the slack between the primitive roads and the final paved road, and it is undoubtedly the best policy to maintain a road in this class until it is possible to construct it actually on the best location and actually laid out with a view to future developments.

Road Building in Brazil.—The President of the State of Rio Grande Do Norte on Oct. 31, signed Law No. 670, which provided for creation of a special fund for state road construction. The sources of revenue specified are: (1) State tax on motor vehicles; (2) contributions from municipalities; (3) gifts from indivduals or associations; (4) product of the sale of surplus state owned motor vehicles; and (5) such other taxes or sources of revenue as may be prescribed in the future.

Walter B. Warren

Walter Burgess Warren, vice president and director of Warren Brothers Co., died suddenly Dec. 9th, 1927, from angina pectoris which followed an acute attack of indigestion. Mr. Warren was born in West Newton, July 29, 1873, the seventh son of Herbert Marshall Warren, long a resident of West Newton. He attended the public schools of West Newton and later of Philadelphia, Pa., graduating from the Central Normal Training School of Philadelphia in 1891. He was a graduate of the University of Pennsylvania in the class of 1895 with the degree of Bachelor of Science and in 1896 received the degree of Mechanical Engineer.

For several years during his college course he acted as timekeeper and foreman for Warren Scharf Asphalt Paving Co. and the Barber Asphalt Paving Co., and after graduation became superintendent for Warren Scharf Asphalt Paving Co. Later as superintendent of Warren Burnham Co. he was in charge of the construction of a hydro electric development at Trenton Falls, New York.

Mr. Warren was one of the partners in Warren Brothers which was formed in 1899 by his brothers, and became a stockholder in Warren Brothers Co. at the time of its incorporation in 1900. In 1901 he became actively interested in the company and had since then devoted his entire business life to the company. He was superintendent in charge of the construction of the first two Bitulithic pavements laid in Pawtucket and New Bedford in 1901. He became the company's general manager shortly thereafter and until 1907 he traveled extensively throughout the United States and Canada in an advisory capacity on construction work.

In 1905 Mr. Warren married Miss Catherine Reed Hooper of Newtonville, Mass., and moved to Portland, Ore., in 1907 where as vice president of Warren Brothers Co. in charge of the business in the Northwest he lived until 1924, returning with his family to Newton, Mass.

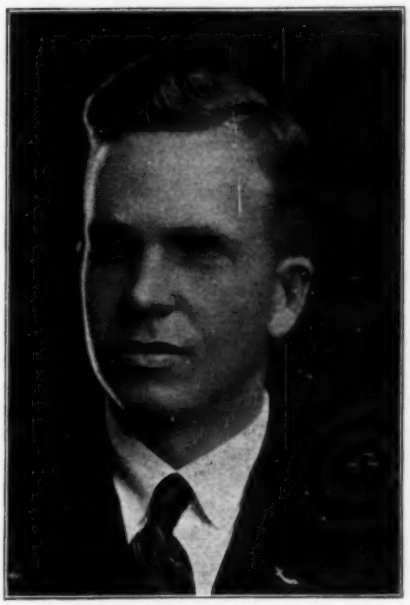
During the past four years Mr. Warren had traveled extensively in foreign countries in the interest of the company. In 1924 he spent several months in Japan supervising the introduction of Warrenite-Bitulithic pavement. A large part of 1925 and 1926 he spent in Cuba interesting the officials and engineers in the pavement, which preparatory work resulted in the award of the Cuban Central Highway for Warrenite-Bitulithic pavement. In 1927 Mr. Warren spent several months in Brazil and Argentina.

Four days before his death, Mr. Warren returned from a trip over the entire Cuba contract work and reported to the Directors the afternoon before his death, of the remarkable progress being made on all branches of the work, and seemed then to be in the best of health.

Howard A. Winton

Howard A. Winton, General Branch Manager, The Heil Co., Milwaukee, Wis., died Feb. 7 at a Milwaukee hospital. Mr. Winton was taken sick at his home in Wauwatosa Jan. 27, and was moved to the hospital on Monday. He was seriously ill from the first with pneumonia and many complications but he made a brave fight for his life with the aid of all possible medical care and attention until the time of his passing.

Mr. Winton entered the employ of the Heil Co. on May 12, 1919. He made rapid progress since that time, holding



Howard A. Winton

positions as advertising manager, general branch manager and secretary of the Hydro Hoist Co.

Mr. Winton was born April 9, 1894. He was graduated in 1915 from Carroll College at Waukesha, where he also did his preparatory work. He was a member of Theta Kappa Epsilon, national fraternity at his college, and took a leading part in almost every campus activity. Following graduation he taught in the High School at Viroqua, Wis., for two years until the United States entered the World War when he enrolled in the First Officers' Training Camp at Fort Sheridan. He served throughout the war as a first lieutenant.

It was during the war when serving with the 32nd Division in Texas that Mr. Winton first met Mrs. Winton who was then Miss Flora Edmond of Waco. The war romance developed and they were married June 22, 1920. There are now three children, all girls, Susan, 16 months; Mary, 4 years, and Katherin, 7 years. Other survivors include his mother, Mrs. Mary G. Winton of Waukesha, and brother, Captain Arthur V. Winton of Fortress Monroe, Va.

Mr. Winton was interested in many activities outside his regular work. He was president of the Milwaukee Association of Industrial Advertisers, captain in the United States Army Reserve Corps, secretary of the Editorial Service Company, Sunday School Teacher at the Wauwatosa Congregational Church and member of the Alonzo Cudworth Post of the American Legion, various Masonic Iodges and Tripoli Temple.

Funeral services were held from the Wauwatosa Congregational Church Thursday, Feb. 9, with burial at Prospect Hill, Waukesha County, Wis., which was the old home of the Winton family.

For the Field Engineer

In the introduction to the Field Manual of the Iowa State Highway Commission for federal and state aid road and bridge work Mr. F. R. White, chief engineer of the Commission, gives the following suggestions to the field engineers:

This manual is prepared to assist you in so discharging your duties that your work will harmonize with the methods and requirements of the general office. You should first become familiar with the regulations herein outlined. Next you should master the details of the particular piece of work to which you have been assigned.

When you show up on a job, you are, in the eyes of the local people, the State Highway Commission. If you make good, the Commission makes good. If you fail, the Commission fails. You may be a hundred miles or more from the district headquarters and twice that distance from the general office. You are, largely speaking, your own boss. This places on you entire responsibility for your conduct. You must often be your own judge of the propriety of any given course of action.

Your first duty is to efficiently, accurately, and honestly perform the duties assigned to you. Your next duty is to make friends of all those with whom you come in contact. If you fail in either of these, you have not made good. The people along the road will appreciate information relative to the improvement proposed. They will ask many questions. Answer them courteously. Go out of your way to give them the information they want. We have no place on our force for the man who gives a smart or insolent reply to any inquiry that may be made of him. Get acquainted with the editors of the local papers. Get them interested in your work. Take them out to see the job. Make friends of them. Get in close touch with the county board, the county engineer, and the auditor. They can help you when you need it. Remember that if you make good, we will hear about it, and if you fail we will hear about that also, even though you are a long way from the office.

The resident engineer or party chief is responsible for the actions of those

under him, as well as for his own actions. If you have a man under you who assumes that he is a superior sort of individual because he is working for the state, fire him. We have no place for such men.

Always assume that your work is wrong until you have checked and rechecked it to such an extent that you have eliminated every possibility of error. Never ignore a suggestion by anyone on the job, even though he be the lowest laborer. He may be right and you may be wrong. I remember an incident that came to my attention some years ago. An engineer was staking out a pier for a viaduct. The foreman of the pile driver doubted the accuracy of the measurement, and expressed his doubts to the engineer. The engineer's reply was: "I'm doing this measuring." "All right," said the foreman, "and you are responsible if it isn't right." Later, after a considerable quantity of work had been done, it was proven that the engineer was wrong. It cost the company many thousands of dollars. It cost the engineer his job. His refusal to listen to the foreman's doubts and to check his own measurements, meant the difference between success and failure.

Another thing. Avoid all appearance of loafing on the job. Never let the members of your engineering force take guns, base balls, bats, or other sporting paraphernalia out to the work with them. You will get "in bad" if you do. We understand, of course, that when there are enough men on your force to do the work promptly and efficiently, there are times when in the natural progress of the work, one or more of your men will be idle for a short time. But the public does not understand these things. They are looking for something to criticize. Don't give them the chance. Arrange your work so as to keep each man busy a maximum per cent of the time. Get your men on to the job promptly in the morning and keep them there until a full day's service has been rendered. This will avoid much talk and criticism from the local people.

Massachusetts Highway Association Elects Officers.—The following officers have been elected by the Massachusetts Highway Association: President, Pehr G. Holmes; vice-president, Arthur E. Blackmer; secretary, John M. McCarthy; treasurer, Charles A. Brown; directors, John A. Gaffey and Franklin C. Pillsbury.

Tennessee to Spend $25,000,000 This Year.—Gov. Henry H. Horton, in a recent address said Tennessee will spend $25,000,000 this year on construction of roads and bridges. This is over $10,000,000 more than has ever gone to this work heretofore.

Aerial Arterial Highway Plan for St. Paul, Minn.

An interesting plan for an aerial arterial highway to be built over the railroad tracks and yards in the downtown district of St. Paul, Minn., has been presented by John F. Druar of Druar & Milinowski, Consulting Municipal Engineers, St. Paul. The purpose of the plan is to provide for the parking of some 4,000 cars and to carry a double street car track so that the street car congestion of the loop district may be supplanted by one way service which will result in greatly speeding up the street car traffic.

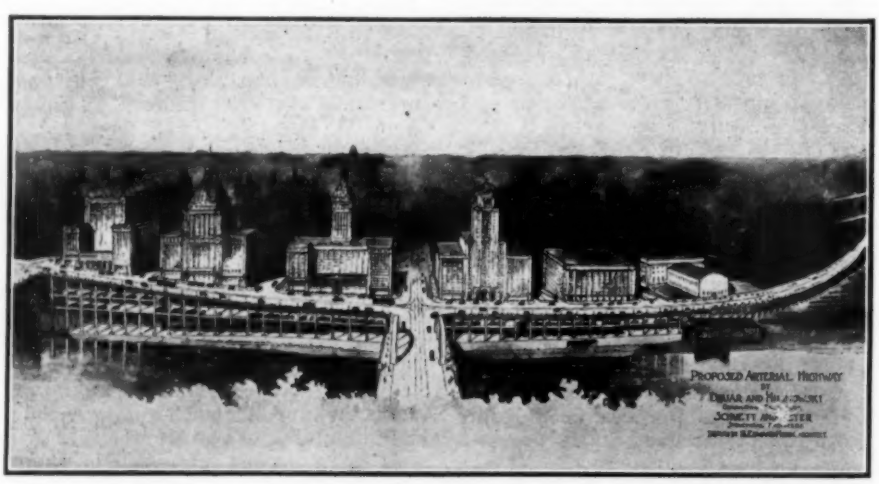
This plan will cost about $6,000,000 and the entire interest on the investment will be borne by auto parking rentals and other concessions. It will afford St. Paul an aerial drive from 70 ft. to 125 ft. above the railroad tracks and nearly two miles long. The south side of the drive will be open and afford a splendid view of the Mississippi River and the opposite bluffs. The north side will abut private property of very little value at the present time but which will become extremely valuable in the future. The problem involves the air rights of the railroad but on the other hand will provide a covered way for the railroad tracks really saving the railroad company a considerable amount of money in winter operation.

The highway proper will be 100 ft. wide 12 ft. walkways being reached by subway so that the pedestrians will not have to cross through traffic. A double street car track will divide the outer or through traffic from the inner lane of local traffic and will be arranged so as to divert the double system of street cars from the narrow congested streets of the loop district. This will speed up both the street car and auto traffic to a great degree.

The outer drive will be a continuous arterial highway from Dayton's Bluff on the east to the High Bridge on the west connecting the federal and state highways from the north and east to the south and west. This highway will be available for entrance to and exit from at the principal street intersection but still will have no cross traffic to contend with. Ramps will connect the Union Depot and excursion docks with the highway and eleven street intersections will be available on which one can enter the local traffic lanes.

The principal feature of this highway will be the great space provided for covered auto parking. This will be accomplished by separate decks below the main highway and approached by ramps from each street intersection. There is space for the parking of about 4,000 cars and from time to time as necessary this can be enlarged at small cost. The parking space can be fully enclosed if considered necessary. The best part of the plan is that the parking of 2,800 cars daily at a reasonable parking charge will pay the interest on the investment and other concessions would go toward a sinking fund to pay off the principal. The parking space is all closely available to the downtown or loop district and will do away with any loop parking. Each street intersection will have its own ramps and the car owner can park his car at the nearest point to his place of business which will not be more than four blocks away. When he enters his car, he may take any one of several lanes of traffic that will lead him without delay or undue congestion to his residential section.

This plan will give St. Paul a splendid scenic highway and when the north side of the highway is built up, it will present a second Michigan Boulevard and Wacker Drive. There will be several plazas for bus stations and shelters for street car patrons. Provision is even made for the future in an upper deck 150 ft. wide by a mile or more in length for a landing field for airplanes with provision for hangars and other accommodations for air travelers.



Artist's Drawing of Proposed Aerial Arterial Highway for St. Paul